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VOLUME 16 NOVEMBER, 1942 NUMBER 6

FUSULINIDAE FROM THE PHOSPHORIA FORMATION OF MONTANA

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ABSTRACT.—There has been considerable controversy over the age of the Phosphoria formation during the past decade. Evidence from brachiopods and ammonoids has been construed to indicate a Leonard or Word age for at least a part of the formation, but few fossils from the base and summit of the formation have been studied. A well preserved fusulinid fauna from limestones just above the Tensleep-Quadrant sandstone, near Three Forks, Montana, is of particular interest for the bearing these fossils have on the age determination of the basal Phosphoria. This is the first record of fusulinids in the Phosphoria. The fusulinids have been identified as *Schwagerina laxissima* Dunbar and Skinner, 1937, and a new species of *Pseudoschwagerina* named *Pseudoschwagerina montanensis* n. sp. These fossils indicate a Lower Permian age for the beds containing fusulinids, and indicate correlation of these beds with the Wolfcamp and Hueco formations of Texas.

THE PURPOSE of this study is to describe a fusulinid fauna discovered in the basal Phosphoria formation, of Permian age, near Three Forks, Montana, and to interpret, in so far as possible, the fusulinid evidence as it affects the Permian stratigraphy of the region.

The fusulinids were found by Mr. Frenzel during the summer of 1940, while assisting Mr. Mundorff in the preparation of a geologic map of an area southwest of Three Forks, Montana. Mr. Mundorff supplied most of the fusulinids used in this study, and furnished the geological map of the area. The stratigraphic section at the locality where the fusulinids were found was measured by Mundorff and Frenzel in the summer of 1940 and was rechecked in 1941 by Frenzel.

We wish to acknowledge advice and criticism from Dr. N. D. Newell in carrying out this study. Also we have discussed with Mr. Benjamin H. Burma various details of fusulinid study and especially the presentation of statistical data in graphical form.

Rocks of Permian age in the region of southwestern Montana, western Wyoming, and southeastern Idaho generally have been classified in the Phosphoria formation. Students of the Permian frequently have suspected that this formation is heterogeneous, both lithologically and faunally, possibly representing a large part of Permian time. The Phosphoria generally is not very thick, ranging up to around 300 or 400 feet; but the abundant phosphatic layers in it have suggested to many workers extraordinarily slow deposition.

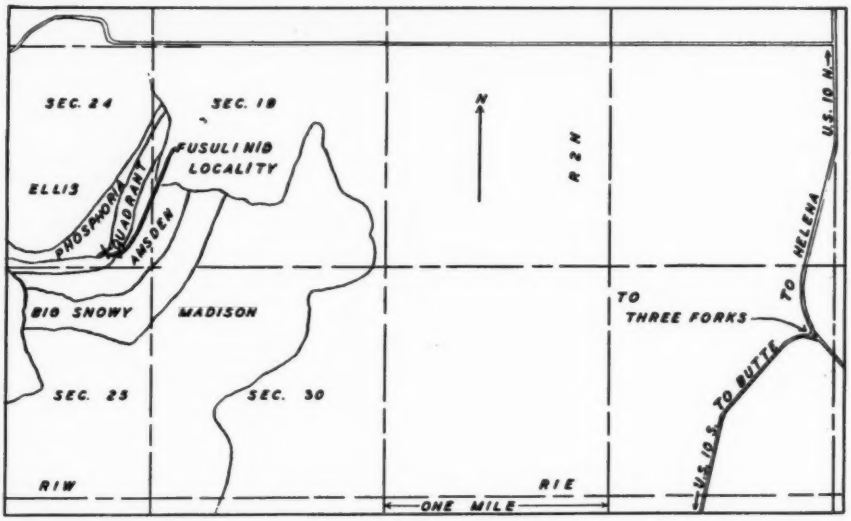


FIG. 1.—Sketch map of fusulinid locality, about six miles west of Three Forks, Montana.

Zonal guide fossils apparently are rare in the Phosphoria fauna, and the most important forms thus far recorded are ammonites found by Miller and Cline (1934, p. 284) in the Sublette Mountains, western Wyoming, 150 feet above the uppermost exposed strata of the Wells formation and 60 feet below the base of the Rex chert. According to Miller and Furnish (1940, p. 23), these ammonites are indicative of Word age, or possibly Leonard age, for the inclosing rocks. The brachiopods of the Phosphoria were tentatively referred by R. E. King (1930, p. 30–33) to the Word series. Until now, fusulinids have never been reported from the Phosphoria beds, but David Love (1939, p. 36) has reported silicified *Parafusulina bösei*, indicative of Word age, from red chert pebbles found in the Jurassic Morrison formation in Montana and Wyoming. Love concluded that Middle Permian rocks were once present in the region. The Phosphoria formation seems to be the probable source. L. G. Henbest in a personal communication reports a fusulinid fauna of Leonard age from the Crooked River Basin, near Paulina, Oregon. The lithologic facies as well as the faunal facies is unlike that of the Phosphoria, and no direct correlation has been attempted between the Phosphoria formation and the Oregon Permian.

During the summer of 1940 we had the good fortune to discover a well preserved fauna of silicified fusulinids in southwestern Montana. These fossils were collected at the base of strata commonly classed as Phosphoria, and were found only in one locality about six miles west of Three Forks, in the southeast quarter of section 24, T. 2 N., R. 1 W., Montana. Immediately beneath the fusulinid-bearing limestone there occurs about 170 feet of cross-laminated, quartzitic sandstone interbedded with thin-bedded calcareous sandstone. This sandstone unit is known by two names, Upper Quadrant, and Tensleep. Scott says, "the Quadrant quartzite is unquestionably a westward extension of the Tensleep sandstone. Geologists working westward from the type locality of the Tensleep invariably classify the quartzite in south-central Montana as Tensleep; whereas those working northward and eastward from Quadrant Mountain identify the same zone in the same section as the Quadrant formation" (1935, p. 1019). Regarding the age of the Tensleep formation C. C. Branson says, "the fauna of the Tensleep formation establishes its age as Des Moines and probably entirely younger than Cherokee." (1939, p. 1223). He also regards the Quadrant and the upper part of the Amsden "as the attenuated edge of the

Tensleep sediments" (1939, p. 1217).

In western Wyoming and southwestern Montana it is customary to class the rocks immediately above the Tensleep sandstone as Phosphoria, although naturally it does not necessarily follow that the initial deposits of the Phosphoria are the same in age from place to place, nor is it certain that the Phosphoria equivalents have been correctly classified in all of the published sections.

In the Three Forks area we have found the Phosphoria formation to be 107.0 feet thick. The following is a detailed section:

PHOSPHORIA SECTION AT FUSULINID LOCALITY, NEAR THREE FORKS, MONTANA

SE¼ sec. 24, T. 2 N., R. 1 W. About 300 yards from road. Dip 35° N.

Bottom of section

		Feet
0.	Quadrant quartzite	
1.	Limestone, dolomitic, silty and clayey; grayish on fresh surface, weathers buff, twin bedded; chert lens at base contains fusulinids	2.3
2.	Quartzite, dark gray and fine grained	0.9
3.	Limestone, light buff, finely crystalline, compact, weathers whitish-gray bringing out fine laminations	3.0
4.	Chert, gray and red, weathers rusty thin bedded	1.0
5.	Limestone, dark gray, finely crystalline, coarsely fractured, weathers light-gray, contains nodules and lenses of bluish-gray to red chert	7.0
6.	Limestone, light buff-gray, dense to fine-grained, clayey, poorly bedded, contains great abundance of chert, usually arranged in bands parallel to the bedding, smoky-brown, weathering light brown, with occasional blue centers; locally contains silicified fossil fragments	20.4
7.	Sandstone, buff and silty, weathers rusty; crossed by quartz veinlets	4.2
8.	Limestone, cherty, similar to 6. (partially covered)	26.0
9.	Quartzitic sandstone, irregularly bedded, base cherty, top cherty and conglomeratic, rounded to angular chert pebbles	3.5
10.	Phosphate, buff-orange with black specks, medium grained, cherty and sandy, with chert pebbles	0.2
11.	Limestone, highly silicious, black, thin bedded, weathers dark gray; contains a few chert nodules	1.5±
12.	Phosphate, locally conglomeratic, black, silicious medium-grained; pebbles are well rounded, gray chert, micro- to medium-crystalline	1.6±
13.	Chert, medium to thin-bedded, weathers rust-brown, greatly fractured; locally contains limey siltstone	7.6
14.	Limestone, black and silicious, very finely crystalline becomes more silicious towards top passing into a chert of similar appearance	2.5
15.	Phosphate, black, oolitic, hard	0.4
16.	Phosphate, similar but less oolitic, grayish-brown	0.3
17.	Unexposed	3.5
18.	Chert, very shaley and clayey, light brown to rusty	1.5
19.	Chert, thin bedded, dark, slightly phosphatic	1.6
20.	Chert, like 18	7.0
21.	Phosphate, black, silicious, fine to medium grained full of structureless pisolites	0.2
22.	Shale, silty, brownish-buff	0.4
23.	Phosphate, black, cherty, mostly fine grained, many structureless pisolites	0.3
24.	Chert, brown	0.2
25.	Limestone, black, silicious, finely crystalline, with grayish-brown shale and dirty brown chert	0.9
26.	Phosphate, very impure, limey and silty, dark gray-brown with black specks	0.1
27.	Chert, smokey brown, irregularly thin bedded to massive	2.3
28.	Phosphate, black and cherty, fine to medium grained, many structureless pisolites	0.1
29.	Unexposed	1.5
30.	Silty shale, buff, weathers rusty, contains chert bands	5.0
	Total Phosphoria	107.0
31.	Sandstone, conglomeratic, beginning with angular chert fragments then well rounded chert pebbles with sparce sandstone matrix, overlain by highly cross laminated sandstone containing Mesozoic clams (Ellis formation).	

There is some question where the exact boundary between the Phosphoria and Quadrant should be drawn. Mundorff has drawn the boundary at the lowest chert and limestone beds. Condit, Finch, and Pardee (1928, p. 179) in a section in Jefferson Canyon near Cardwell, Montana, include 30 feet of dark gray, cross-laminated sandstone in the Phosphoria formation. However, the same writers (1928, p. 184) at Cinnamon Creek, SW¼ sec. 17. T. 8 S., R. 4 E., Montana, draw the basal Phosphoria boundary at the lowest phosphatic rock, and include in the Quadrant 39 feet of sandstone between the phosphatic beds and the typical Quadrant

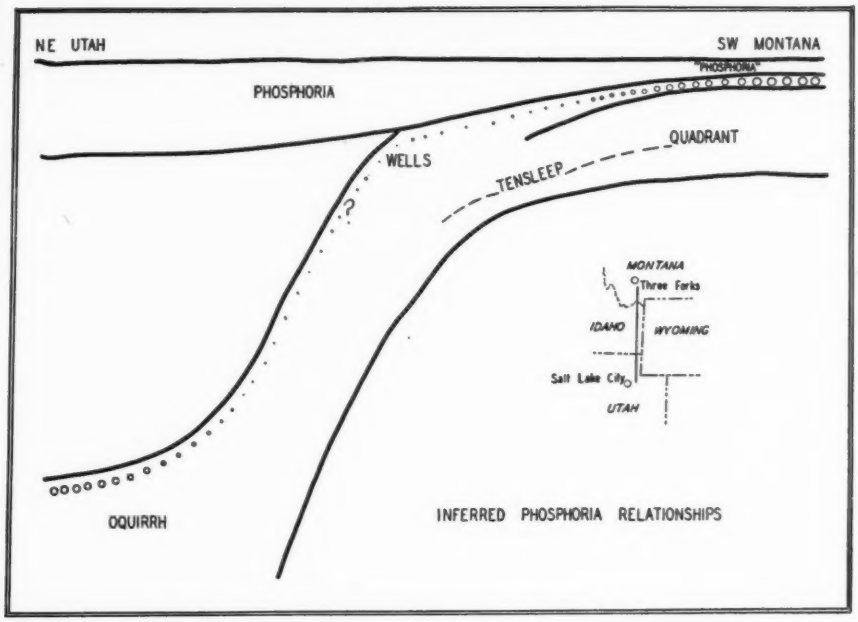


FIG. 2.—Digrammatic section from Three Forks, Montana to northeastern Utah, showing probable correlation. The circles indicate the position of *Pseudoschwagerina*. It seems probable that the fusulinid-bearing beds at the base of the "Phosphoria" in the Three Forks area are much older than the typical Phosphoria of northeastern Utah.

quartzite. In other sections no attempt is made to differentiate between the Phosphoria and Quadrant formations. The disconformity which must represent the later Pennsylvanian is not recognized, and fossils denoting middle or upper Pennsylvanian age have not been found in this area.

The fusulinids were identified as *Schwagerina laxissima* and a new sepcies of *Pseudoschwagerina*. *Pseudoschwagerina* in America is indicative of the lower Permian, and its occurrence in the Phosphoria suggests that the fusulinid-bearing part of the formation is equivalent to the Wolfcamp and Hueco of Texas. *Schwagerina laxissima* indicates a lower Permian age of the enclosing rocks, as the species *S. laxissima* is characteristic of the upper part of the Hueco limestone in the Franklin Mountains and at about the same horizon in Marble Canyon in the Sierra Diablo, Texas (Dunbar and Skinner, 1937, p. 654). The genus *Schwagerina*, however, is known to occur also in the Leonard formation.

The fusulinid evidence considered together with evidence from ammonites and brachiopods indicates that the beds generally known as the Phosphoria formation are certainly referable to more than one stage of the Permian system.

That the *Pseudoschwagerina* zone has never been recognized in the Phosphoria of Wyoming and Idaho does not indicate that strata of Wolfcamp age do not occur there, but it also is possible that the *Pseudoschwagerina* zone should be sought in the upper limestone of the Wells formation.

The *Pseudoschwagerina* zone has been recognized in northern Utah in the Oquirrh formation. According to Baker and Williams (1940, pp. 626–627) the Oquirrh formation is enormously thick and is a fairly uniform lithologic unit without marked divisions. Fusulinids are abundant in it but have not been found in the overlying strata considered by them to be Permian in age. However, *Pseudoschwagerina* was identified by M. L. Thompson, in 1936, from at least one

collection made by H. L. Bissell from the upper part of the Oquirrh formation. Baker and Williams tentatively assign to the Permian 2900 feet of strata between the Oquirrh formation and beds which they correlate on lithologic grounds with the base of the Phosphoria.

As previously noted David Love has reported silicified *Parafusulina bösei* in red chert pebbles found extensively in the Morrison formation in central and northern Wyoming and southern Montana. Love (1939, p. 36) postulated a source for the chert pebbles to the west or southwest, in Idaho or Utah, possibly the Idaho volcanic area. He stated that some of the pebbles are several inches in diameter. A more northerly source might just as well be postulated, with the Morrison fusulinids being derived from some part of the Phosphoria in western Montana. Cephalopods found by Miller and Cline in the Sublette Mountains of western Wyoming show that rocks of Word age occur in the Phosphoria. These cephalopods indicate an age about the same as that of *Parafusulina bösei*. Inasmuch as fusulinids of Wolfcamp age occur at the base of the Phosphoria in Montana, it is logical to suspect that rocks of Leonard or Word age occur higher in the Phosphoria in Montana.

The fusulinids found in the Morrison formation by Love are said to be silicified and to occur in red chert. The preservation seems to be identical with that of the lower Permian fusulinids found near Three Forks. Reddish chert is found throughout the Phosphoria in the Three Forks area. The facts suggest a source in western Montana for the red chert pebbles containing *Parafusulina bösei*.

We know of no place in Montana or surrounding area in which the Morrison formation is in contact with the Phosphoria or older horizons. Either the pebbles came from farther west or south as Love has postulated or they came from some local uplift that had been elevated prior to Morrison time, supplying part of the Morrison sediments.

In summary, the fusulinids from Three Forks show that beds of Wolfcamp age overlie the Des Moines Quadrant, at least locally, in southwestern Montana. The suggestion by Baker and Williams that the base of the Phosphoria in northern Utah is stratigraphically as much as half a mile above the *Pseudoschwagerina* zone suggests that the fusulinid beds at Three Forks may be older than the type Phosphoria of southeastern Idaho. In this respect usage of the term Phosphoria simply follows local application of the term. Faunal evidence from western Wyoming and southeastern Idaho shows that at least part of the Phosphoria is younger than Wolfcamp, presumably equivalent in age to the Word or possibly the Leonard, and in absence of satisfactory faunal data it may be that the uppermost Phosphoria may be even younger than Word.

SYSTEMATIC DESCRIPTIONS

Family FUSULINIDAE

Genus PSEUDOSCHWAGERINA Dunbar and Skinner, 1936

Pseudoschwagerina DUNBAR and SKINNER, *1936*, Jour. Paleontology, vol. 10, p. 89; ——, *1937*, Texas Univ. Bull. 3701, p. 656, pl. 50 and pl. 53, fig. 8.

Schwagerina (part) of authors except Möller, *1877*.

Genoholotype: *Pseudoschwagerina uddeni* (Beede)

The new species of *Pseudoschwagerina* from Montana described in this study does not precisely fit the generic diagnosis given by Dunbar and Skinner in 1937. They state: "Septa rather feebly and irregularly fluted, the folds being chiefly developed near the basal margin. In some species the septa are nearly plane, and even where rather strongly fluted they are so widely spaced that opposed folds of adjacent septa do not normally meet." In some advanced *Pseudoschwagerinas*, including the new species described below, the septa are regularly fluted in the outer volutions, with the crests of the septal folds touching in physical contact. Septa in the genus *Pseudoschwagerina* are rather feebly and irregularly fluted or nearly plane in the upper two thirds. In the lower third of later septa, however, the fluting may be regular and fairly intense. In forms like *P. texana* and *P. montanensis*, n. sp. having intense fluting basal foramina are in a few instances irregularly developed to form discontinuous communications similar to cuniculi.

The fluting may be almost as regular as in *Paraschwagerina*, but the folds extend only one-third or less up the septum from the margin. The new species from Montana is not to be confused with species of *Paraschwagerina*, as it lacks the elongate juvenarium and the small proloculum characteristic of that genus.

PSEUDOSCHWAGERINA MONTANENSIS
Frenzel and Mundorff, n. sp.
Plate 99, figures 1–8; plate 100, figures 7–11

The Montana species is medium-sized, of 6 or 7 volutions. It varies in shape from fusiform to ventricose, ranging in length from 9 to 11 mm., and having a diameter of from 5.5 to 8 mm. The axial profile in the third and fourth volutions generally is fusiform, with fairly sharp poles. In the fifth, sixth, and seventh volutions, the profile becomes evenly elliptical, with rounded ends.

The proloculum is large, with a considerable range in size, from about 250 microns to 420 microns. The juvenarium comprises $2\frac{1}{2}$ to $3\frac{1}{2}$ volutions, but is not as distinctly separated from the latter whorls as in other species of *Pseudoschwagerina*. This gradation is due to the more even increase of the rate of growth. The last volution decreases perceptibly in height. The form ratio is fairly constant after the first volution, being commonly about 2 and occasionally going as high as 2.5.

The wall is quite thick in the outer volutions measuring 110 to 130 microns. Small chomata are present in the juvenarium, but are lacking in the inflated whorls.

The fluting of the septa in *P. texana* and the new species is distinctly different from the fluting in *P. beedei*, *P. uddeni*, and *P. gerontica*. In the last species the septa are nearly plane in the upper part next to the spirotheca from which they descend. In the lower part near the margin of the septa weak irregular folds are developed, but even in the outer whorls the folds do not meet. The fluting is more advanced in *P. texana* and the new species. In the upper third of the septa, near the spirotheca from which it has grown, the septa are nearly a plane (Pl. 99, fig. 5). In the intermediate third the fluting is weak and irregular (Pl. 100, fig. 10). In the lower

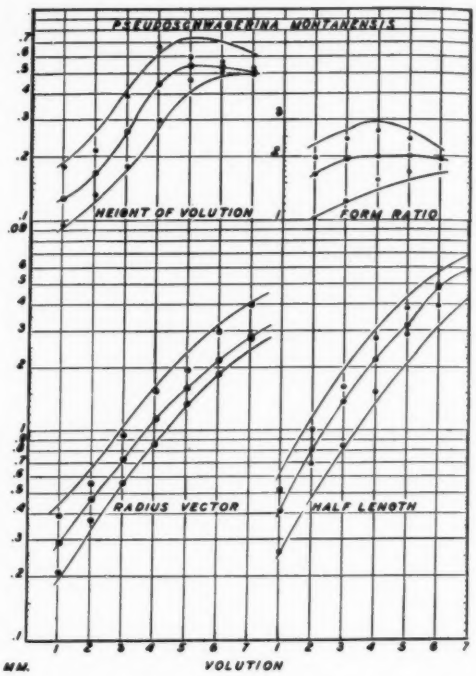


FIG. 3.—Graphical representation of minimum, average, and maximum values in *Pseudoschwagerina montanensis*, n. sp.

third near the margin of the septa the fluting is strong and regular. Opposed folds meet, and elongate chamberlets are formed. On the base of the next whorl basal foramina are developed in the septa and the elongate chamberlets become interrupted passageways similar to cuniculi, which extend through two, three, or four septa (Pl. 100, figs. 7–9).

This type of fluting is quite similar to that of *Paraschwagerina*, but the fluting in the upper two thirds is weaker than in *Paraschwagerina*, while it is apparently further advanced in the lower third than that of *Paraschwagerina*, judging from the published descriptions.

In axial sections septal loops are largely restricted to the lower third of each septum, and generally the septa are so nearly plane above that they appear in the upper part only when chance sectioning cuts them. Septal pores are abundant in the inflated whorls, appearing first in the end zones.

The following table gives the maximum,

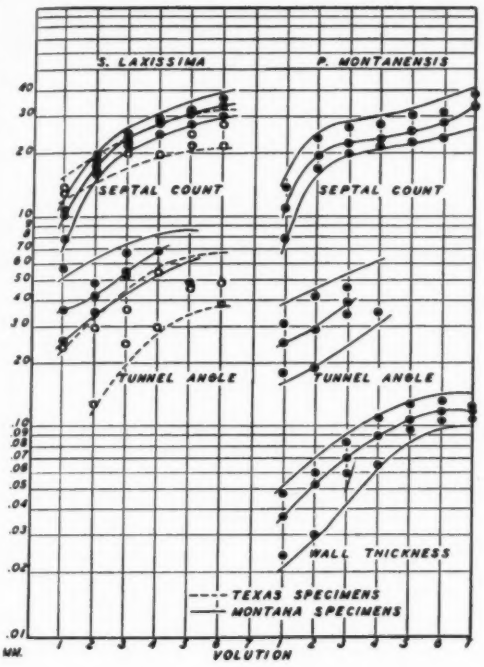


FIG. 4.—Graphical representation of minimum, average, and maximum values for *Schwagerina laxissima* and *Pseudoschwagerina montanensis*.

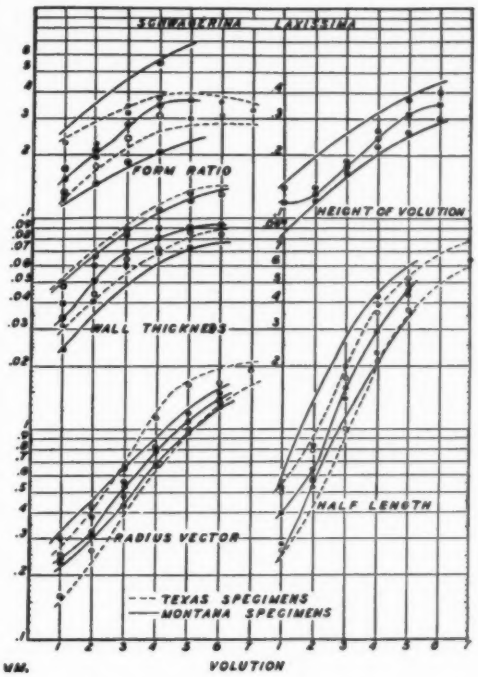


FIG. 5.—Graphical representation of minimum, average, and maximum values for *Schwagerina laxissima*.

average, and minimum values for the different measurements, and the number of specimens measured. The graphs present the same data.

Discussion.—This species displays considerable variation in the profile of the axial section, in the radius vector, and heighth of volution. Casual inspection would lead one to expect that two species are present. Some specimens look like *P. beedei* in axial profile while others look more like *P. texana* var. *ultima*. However, when a large number of specimens are studied gradation from one extreme to the other is apparent. Graphical plotting of radius vector and height of volution shows a complete gradation between the two types with a majority of the specimens lying between the extremes.

Measurements of this species when compared with values of other species, as described by Dunbar and Skinner, exhibit consistent differences. *P. beedei* is listed with proloculum ranging only up to 260 microns while the Montana species has larger proloculi ranging up to 420 microns. The Montana species also has larger half lengths and radius vectors. Like *P. beedei*, however, the inflation takes place gradually and the juvenarium is not as distinct as in *P. uddeni*. The septal fluting of *P. beedei* is weak and irregular, quite different from that of *P. montanensis*.

Pseudoschwagerina montanensis is easily distinguished from *P. uddeni* by the smaller half length, radius vector, and form ratio. The fluting of *P. montanensis* is also more advanced.

Pseudoschwagerina texana, which the new species most closely resembles, ranges higher in half length and radius vector values than the Montana specimens. The form ratio is distinctly higher, especially in the fourth and fifth volutions. Dunbar and Skinner state that the proloculum of *P. texana* ranges from 200 to 400 microns while the proloculum of *P. montanensis* was found to range from 250 to 420 microns. In axial profile *P. texana* is generally fusiform while *P.*

DIMENSIONS IN SPECIMENS OF PSEUDOSCHWAGERINA MONTANENSIS[1]

Half Length (mm.) whorl	1	2	3	4	5	6	7
max.	.52	1.00	1.60	2.72	3.80	4.80	
ave.	.41(9)	.78(9)	1.33(9)	2.10(7)	3.20(6)	4.39(3)	5.80(1)
min.	.26	.69	.84	1.51	2.85	3.90	
Radius Vector (mm). whorl	1	2	3	4	5	6	7
max.	.39	.56	.95	1.54	1.92	2.98	4.00
ave.	.29(20)	.47(19)	.72(16)	1.13(12)	1.60(7)	2.19(5)	3.42(2)
min.	.21	.37	.56	.86	1.33	1.85	2.83
Form Ratio whorl	1	2	3	4	5	6	
max.	2.00	2.08	2.46	2.80	2.48		
ave.	1.45(9)	1.69(9)	1.97(9)	1.98(7)	2.03(5)	1.94(1)	
min.	.88	1.23	1.34	1.23	1.58		
Height of Volution (mm.) whorl	1	2	3	4	5	6	7
max.	.18	.22	.39	.67	.60	.52	
ave.	.13(20)	.17(18)	.26(15)	.39(12)	.54(6)	.51(3)	.50(1)
min.	.10	.13	.18	.30	.47	.51	
Wall Thickness (mm.) whorl	1	2	3	4	5	6	7
max.	.05	.06	.08	.12	.13	.13	.12
ave.	.04(17)	.05(18)	.07(16)	.09(12)	.11(8)	.12(3)	.12(2)
min.	.02	.03	.06	.07	.11	.11	.11
Septal Count whorl	1	2	3	4	5	6	7
max.	14	24	27	28	31	32	
ave.	11(18)	20(17)	23(15)	24(10)	26(4)	28(3)	39(1)
min.	8	17	20	22	23	24	
Tunnel Angle (degrees) whorl	1	2	3	4			
max.	31	42	46				
ave.	25(7)	29(7)	38(4)	34(2)			
min.	18	19	34				

[1] Numbers in parentheses indicate number of specimens used.

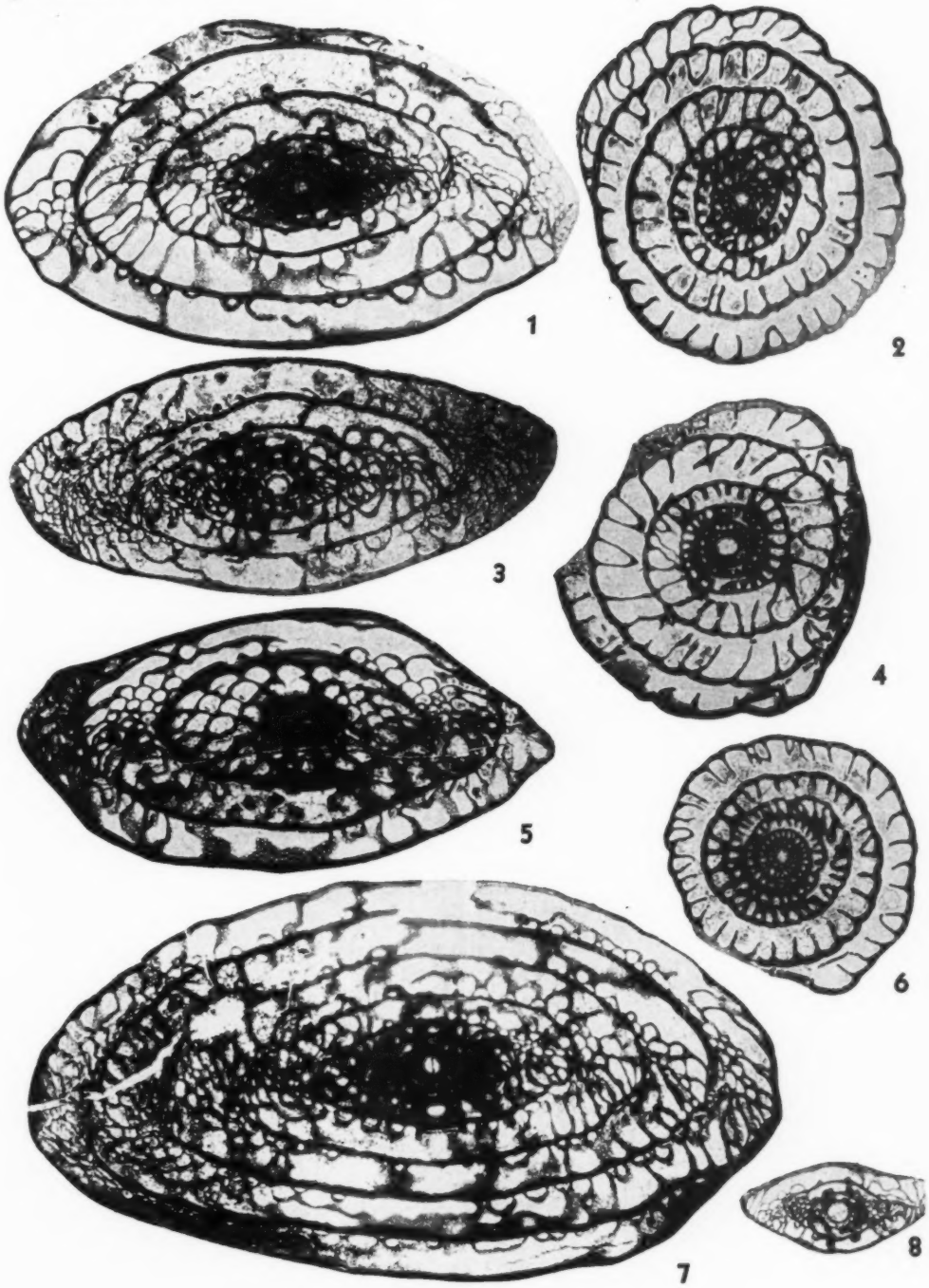
montanensis is more ventricose. As previously noted the septal fluting is similar to that of *P. texana*.

Occurrence.—The new species was found in a chert bed about a foot thick at the base of the limestone and chert beds which are locally called Phosphoria. As previously noted it occurs just above a sandstone which lies

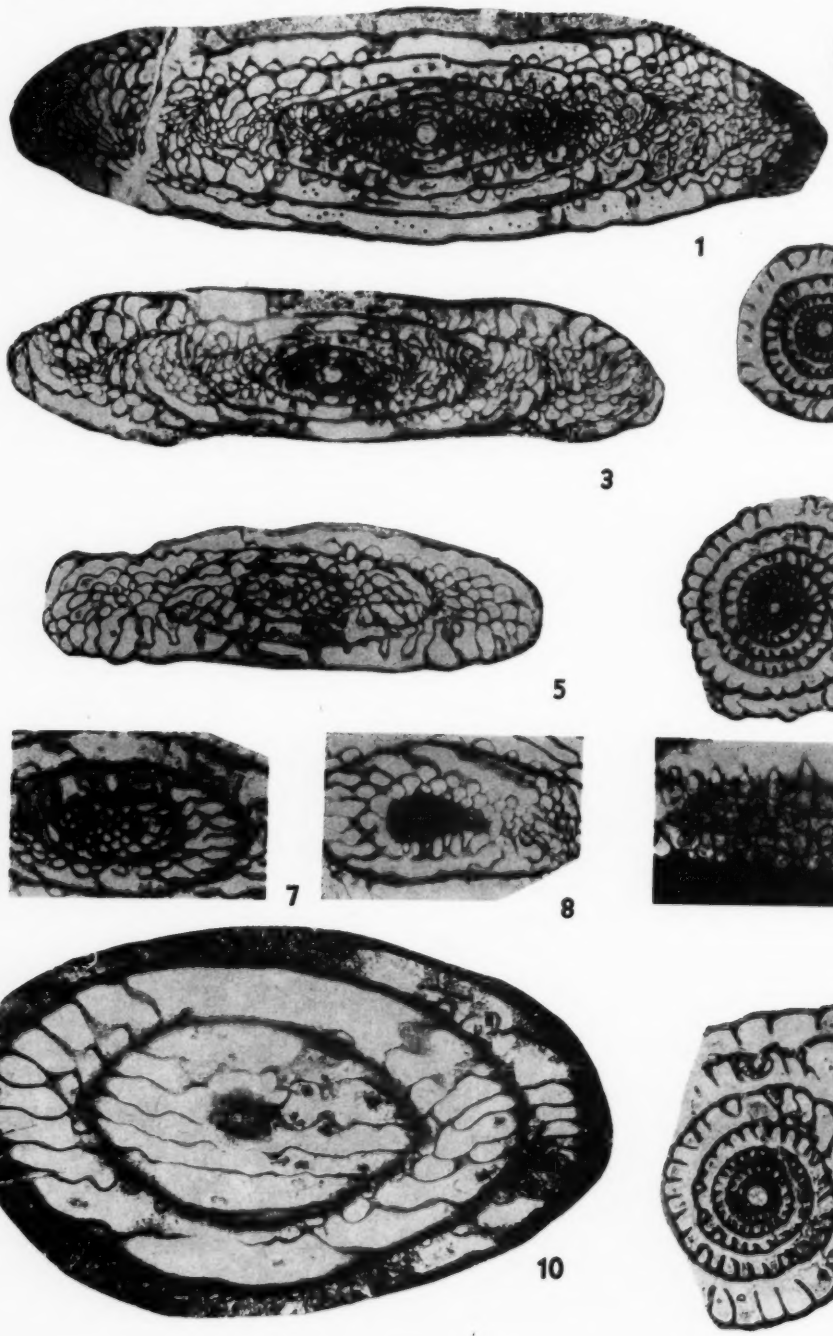
EXPLANATION OF PLATE 99

All illustrations ×10

FIGS. *1–8—Pseudoschwagerina montanensis* Frenzel and Mundorff n. sp. From a reddish chert bed at the base of the Phosphoria formation, SE¼ sec. 24, T. 2 N., R. 1 W., Montana. 1, Axial section of a paratype Univ. Wisconsin 21316; 2, Sagittal section of a paratype Univ. Wisconsin 21317; 3, Axial section of a paratype Univ. Wisconsin 21318; 4, Sagittal section of a paratype Univ. Wisconsin 21319; 5, Tangential section of a paratype Univ. Wisconsin 21320, showing septal pores and intense fluting in outer whorls and straight septa on inner whorl when cut near the whorls from which the septa grew; 6, Sagittal section of a paratype Univ. Wisconsin 21321; 7, Axial section of the holotype Univ. Wisconsin 21322, it is intermediate in form between figures 1 and 3; 8, Axial section of a paratype Univ. Wisconsin 21323, showing clearly the juvenarium. (p. 680)



Frenzel and Mundorff, Permian Fusulinids



Frenzel and Mundorff, Permian Fusulinids

DIMENSIONS IN SPECIMENS OF SCHWAGERINA LAXISSIMA[2]

Half Length (mm.) whorl	1	2	3	4	5		
max.	.52	.94	1.74	4.26	4.86		
ave.	.40(4)	.83(4)	1.62(4)	2.99(4)	4.60(2)		
min.	.28	.66	1.41	2.10	4.34		
Radius Vector (mm.) whorl	1	2	3	4	5	6	
max.	.30	.42	.56	.82	1.19	1.48	
ave.	.27(4)	.38(4)	.51(4)	.78(4)	1.08(3)	1.39(2)	
min.	.24	.32	.48	.77	1.00	1.31	
Form Ratio whorl	1	2	3	4	5		
max.	1.72	2.03	3.33	5.55			
ave.	1.54(4)	1.76(4)	2.65(4)	3.51(4)	3.68(2)		
min.	1.33	1.43	1.85	2.06			
Height of Volution (mm.) whorl	1	2	3	4	5	6	
max.	.14	.14	.18	.26	.37	.40	
ave.	.12(4)	.13(4)	.17(4)	.25(3)	.32(3)	.35(2)	
min.	.10	.12	.17	.24	.25	.30	
Wall Thickness (mm.) whorl	1	2	3	4	5	6	
max.	.048	.060	.084	.090	.120	.096	
ave.	.034(4)	.052(4)	.069(4)	.079(4)	.092(3)	.093(2)	
min.	.024	.042	.060	.072	.072	.084	
Septal Count whorl	1	2	3	4	5	6	7
max.	11	19	25	30	32	37	
ave.	10(3)	18(3)	24(3)	28(3)	30(2)	34(2)	36(1)
min.	8	17	23	25	28	31	
Tunnel Angle (degrees) whorl	1	2	3	4			
max.	58	49	58				
ave.	37(4)	42(4)	57(2)	70(1)			
min.	26	36	57				

[2] Numbers in parentheses indicate number of specimens used.

EXPLANATION OF PLATE 100

All illustrations ×10

FIGS. *1–6—Schwagerina laxissima* Dunbar and Skinner. From a reddish chert bed at the base of the Phosphoria formation, SE¼ sec. 24, T. 2 N., R. 1 W., Montana. 1, Axial section of hypotype Univ. Wisconsin 21324; 2, Sagittal section of hypotype Univ. Wisconsin 21325; 3, Axial section of hypotype Univ. Wisconsin 21326; 4, Sagittal section of hypotype Univ. Wisconsin 21327; 5, Tangential section of a hypotype Univ. Wisconsin 21328; 6, Sagittal section of hypotype Univ. Wisconsin 21329. (p. 684)

7–11—Pseudoschwagerina montanensis Frenzel and Mundorff, n. sp. From a reddish chert bed at the base of the Phosphoria formation, SE¼ sec. 24, T. 2 N., R. 1 W., Montana. 7, Tangential section of paratype Univ. Wisconsin 21330, showing intense fluting near the margin of the septa; 8, Tangential section of a paratype Univ. Wisconsin 21331, showing development of elongate chamberlets by the septa between the third and fourth volutions; 9, Tangential section of a paratype Univ. Wisconsin 21332, showing septa that have developed basal foramina and formed passageways similar to cuniculi between the fifth and sixth volutions; 10, Tangential section of a paratype Univ. Wisconsin 21333, showing the alveolar character of the wall structure; 11, Sagittal section of a paratype Univ. Wisconsin 21334, this section illustrates the peculiar phenomenon which White (1936, p. 130, pl. 20, figs. 6, 7) interpreted as the development (in triticites) of the microspheric embryo in the megalospheric form due to the uniting of the zoospores within a living host. (p. 680)

between the limestone beds and the typical Quadrant quartzite.

SCHWAGERINA LAXISSIMA
Dunbar and Skinner, 1937
Plate 100, figures 1–6

Schwagerina laxissima, DUNBAR and SKINNER, *1937*, Texas Univ. Bull. 3701, p. 652, pl. 68.

The Montana specimens of this species appear to be like the typical material from Texas. The Montana specimens are elongate with rounded ends. There are 6 and probably 7 volutions which attain a length of 8 to 10 mm. The form ratio increases gradually from about 1.5 in the first volution to 3 to 5 in the fifth and declining somewhat thereafter. The proloculum is moderately large ranging from 200 to 312 microns. The height of volution is large for a *Schwagerina* and increases rapidly from .12 mm. in the first volution to .35 mm. in the sixth.

The wall thickness is large in the inner volutions ranging from .042 mm. to .06 mm. in the second volution; in the fifth volution a maximum of .12 mm. was found.

Small, irregularly placed chomata form highly variable tunnel angles in the inner volutions, and are lacking in the outer volutions. Secondary deposits thicken the whorls and septa, especially in the inner whorls, but there is less secondary deposit than in the Texas specimens. The spirotheca consists of a tectum and a coarsely lamellar kerotheca.

The fluting is strong and regular in the lower part, near the margin of the septa where opposed folds meet. The upper third of the septa is nearly plane. In axial section the septal loops are broad and irregular, and are not as high as in many of the *Schwagerinas*. Septal pores are abundant in the outer volutions.

Discussion.—The *Schwagerina* from Montana is identified with *Schwagerina laxissima* Dunbar and Skinner, 1937. In figure 5 the measurements of Dunbar and Skinner (in dotted lines) are compared with the specimens from Montana (in continuous lines). The range of measurements check in all important respects. Dunbar and Skinner list proloculum sizes ranging from 200 to 312 microns. The Montana specimens studied have proloculi ranging from 200 to 312 microns. The axial profile, and appearance of fluting in the photographs are almost identical. Minor discrepancies are believed due to an inadequate number of specimens. Dunbar and Skinner list measurements for only three specimens. The Montana specimens also are probably inadequately represented, as only four axial sections and four sagittal sections were used. The only marked discrepancy is in the tunnel angle which is highly variable, and very difficult to measure in the advanced *Schwagerina*, where chomata are often rudimentary, or lacking.

Occurrence.—Dunbar and Skinner illustrate types collected by L. A. Nelson from the Hueco limestone in the slope opposite Anthony, in the Franklin Mountains about 15 miles north of El Paso, Texas. They also report them from the upper part of the Hueco limestone on the east slope of Victoria Peak and at about the same horizon in Marble Canyon, in the Sierra Diablo, Texas. The types here described are from about 6 miles west of Three Forks, Montana, from a chert bed at the base of the Phosphoria.

REFERENCES

BAKER, ARTHUR, A. and WILLIAMS, JAMES STEELE, *1940*, Permian in parts of Rocky Mountain and Colorado Plateau regions: *Am. Assoc. Petroleum Geologists Bull.*, vol. 24, pp. 617–635.

BRANSON, C. C., *1939*, Pennsylvanian formation of central Wyoming: *Geol. Soc. Am. Bull.*, vol. 50, pp. 1299–1225.

CONDIT, D. D., FINCH, E. H., and PARDEE, J. T., *1928*, Phosphatic rock in the Three Forks-Yellowstone Park region, Montana: *U. S. Geol. Survey Bull. 795-G*, pp. 147–209.

DUNBAR, CARL O. and SKINNER, JOHN W., *1937*, Permian Fusulinidae of Texas: *Texas Univ. Bull. 3701*, pp. 524–825.

KING, R. E., *1930*, The geology of Glass Mountains, Texas: *Texas Univ. Bull. 3042*, pp. 1–245.

LOVE, JOHN DAVID, *1939*, Geology along the southern margin of the Absaroka Range, Wyoming: *Geol. Soc. Am. Spec. Paper 20*, pp. 1–134.

MILLER, A. K. and CLINE, L. M., *1934*, The Cephalopods of the Phosphoria formation of northwestern United States: *Jour. Paleontology*, vol. 8, pp. 281–302.

MILLER, A. K., and FURNISH, W. M., *1940*, Permian Ammonoids of the Guadalupe Mountain region and adjacent areas: *Geol. Soc. Am. Spec. Paper 26*, pp. 1–242.

SCOTT, HAROLD W., *1935*, Some Carboniferous stratigraphy in Montana and northwestern Wyoming: *Jour. Geol.*, vol. 43, pp. 1011–1032.

WHITE, M. P., *1936*, Some Fusulinid Problems: *Jour. Paleontology*, vol. 10, pp. 123–133.

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INVERTEBRATE FAUNAS FROM THE BLAINE AND THE DOG CREEK FORMATIONS OF THE PERMIAN LEONARD SERIES

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ABSTRACT.—Certain fossiliferous limestones occur in association with massive gypsums in the Blaine and the Dog Creek formations of Kansas, Oklahoma and Texas. From such limestones thirty-seven species of fossil invertebrates are recognized, four of which are described as new. These species are assigned to thirty-one genera. The fossils, though poorly preserved and variously distributed in the formations, are important with respect to studies of related Permian faunas. It is observed that the Blaine and the Dog Creek faunas are nearly identical and that they resemble those known from the upper Leonard of western Texas and those from the San Andres group of New Mexico.

THE INVERTEBRATE faunas that occur in middle and late Permian strata of Kansas, Oklahoma, and Texas represent impoverished elements derived from rich invertebrate faunas of early Permian strata. In Kansas, Oklahoma, and Texas, middle and late Permian strata consist of varicolored shales and sandstones, massive gypsums and anhydrites, thin limestones and dolomites, and salt precipitates. These strata are often regarded collectively as a red bed section all but barren of fossil forms. It is now known that invertebrate fossil assemblages occur in the Blaine and the Dog Creek formations of this section.

The discovery of invertebrate fossils in the Permian "red beds" of Oklahoma and Texas, during the period from 1890 to 1910 was an item of more than usual significance and merits review. Cummins, in 1891, noted a rich cephalopod fauna in certain limestones of the Dog Creek formation, at the falls of Salt Croton Creek in Stonewall County, Texas. Subsequently, Hyatt and later, J. P. Smith, described cephalopods from this locality. In 1937 Plummer and Scott described certain ammonoids from the Croton Falls area and from an area in Hardeman County, near Quanah, Texas. Miller and Furnish described ammonoids from the same localities in 1940.

Gould, in 1900, noted the occurrence of a few pelecypods in the Blaine formation at localities in Blaine and Kingfisher counties of Oklahoma. Gould in 1902 noted the cephalopod fauna in outcrops of the Blaine near Quanah, Texas.

Contemporaneous with others, Beede made important contributions to Permian paleontology in the period from 1900 to 1930. Beede, very early in the period, noted an ammonoid fauna in the Dog Creek formation, near Guthrie, Texas and he noted the occurrence of fossil pelecypods at several localities of the Blaine and the Dog Creek in Texas.

The writer's interest in the paleontology of middle and late Permian strata, specifically the Blaine and the Dog Creek formations, relates to a period that began in 1927, when the ammonoid, *Perrinites*, was discovered in Blaine outcrops of Kingfisher County, Oklahoma. Since that time, the writer has augmented the collections of cephalopods and other invertebrate fossils, from middle and late Permian strata on many occasions, coincident with geological investigations in Kansas, Oklahoma, Texas, and New Mexico.

The writer was not without the aid of others in preparing the manuscript; to those his sincere acknowledgments are due. Particularly is he grateful to Dr. W. M. Furnish for advice concerning the paper and some of the specimens, and for aid in final field collecting of critical material; to Dr. F. B. Plummer and Dr. E. H. Sellards for the opportunity to examine museum fossil specimens; and to those authors whose works the writer has so freely consulted. The writer assumes responsibility for whatever error the paper may have.

In Kansas, Oklahoma, and Texas the Blaine is everywhere underlain by the

Flower-Pot formation (Table 1). The Dog Creek, which overlies the Blaine, is in turn overlain by the Whitehorse sandstone, wherever that sandstone has not been removed by subsequent erosion.

TABLE 1.—UPPER LEONARD SERIES IN KANSAS, OKLAHOMA AND TEXAS

SERIES	FORMATION	MEMBER
GUADALUPE	Whitehorse	
LEONARD	Dog Creek	Childress Member Unnamed shales and gypsums Aspermont Member Shales Guthrie Member (*Perrinites* Zone) Shales
	Blaine	Shimer Member Shales Acme Member (*Perrinites* Zone) Shales Cedartop Member Shales Medicine Lodge Member
	Flower-Pot	

The fossiliferous limestone beds in the Blaine and the Dog Creek occur beneath massive gypsum and are usually at the base of an evaporite member of the formation. In some cases limestones included in the massive gypsum contain fossils, and, very rarely, specimens are found in the gypsum itself. For such strata the most favorable collecting localities are eroded terranes, from which most of the gypsum has been removed, and where the limestones persist as erosion remnants or as escarpment-forming ledges.

Invertebrate fossil localities for each of the precipitate members of the Blaine occur in Oklahoma and Texas. However, the Acme member is fossiliferous enough that the trace of its surface expression is an attenuated series of fossil-bearing limestone outcrops. At many localities only a single species is represented, but at some localities several species are abundant. The ammonoid *Perrinites hilli* (Smith), an important index form, is known to occur at three localities in the Acme of Oklahoma and at the same number of localities in Texas.

In southwestern Oklahoma and in Texas, invertebrate fossils occur at many localities in the Guthrie and in the Aspermont members of the Dog Creek formation. At the top of the formation, a few pelecypod fossils are present at some localities in the Childress member. It is noted that the sequence of fossil-bearing precipitates in the Dog Creek is similar to that of the Blaine.

The Guthrie member of the Dog Creek is important for its fossiliferous limestones. At this horizon the ammonoid *Perrinites hilli* (Smith), is known to occur at six localities in Texas. One of these localities, near the Childress-Hardeman County line, is about fifteen miles from an important *Perrinites* locality in the underlying Acme member of the Blaine, near Quanah, Texas.

Most of the fossils occur as casts or molds, so intimately associated with the matrix that separation is difficult. Occasionally a calcified or a partly silicified shell may be found, and aragonitic tests are not uncommon. Individual fossils may preserve so little detail that the systematist is required to study numerous fragmentary specimens in order to note taxonomic features of the species.

Certain deductions related to Permian ecological conditions and to the manner of preservation are reflected by the state in which the fossils are now found to occur. It is observed that the shells often evidence little abrasion; pelecypods in bivalved condition are not uncommon, and their present positions show little or no evidence of orientation due to currents. At many localities great numbers of one or more species may form a coquina composed of casts and molds, often with much fragmentary shell material. Not uncommonly, occurrence is apparently restricted to a very small area of the outcrop. The distribution of fossils even in the thin limestones is usually not uniform vertically. The fossils may be limited to a very thin zone only, or they may occur in varying aggregates throughout the thickness of the bed. At one important locality where the limestone section has a thickness of eight feet or more, the fossils appear to be essentially limited to a one-foot zone and never occur in a thickness as great as three feet. At the classic Croton Falls area of Stonewall County, Texas,

where the limestone section is eight to ten feet thick, the fossils occur in various aggregates and associations. Here, the ammonoid fauna is limited to a zone no more than half the total thickness, while other invertebrates occur unequally distributed throughout the limestone beds.

The faunas are noteworthy not alone for the orders, genera, and species represented, but for the absence from the assemblages of those forms that are usually associated with similar faunas elsewhere. The brachiopods and the gastropods are poorly represented and no fusulinids have been found in the assemblages. The collections while not exhaustive are believed to be representative, and they now include at least thirty-seven species. There are fourteen pelecypods, two gastropods, two brachiopods, seven or more nautiloids, seven ammonoids, two bryozoans, one scaphapod, one crinoid, and one polychaet.

The nautiloids are outstanding for the number of species and genera represented as well as for their size and diversity in development. The orthoconic, cyrtochoanitic nautiloids are represented by no less than four species, distributed in three genera, while the coiled forms are represented by no less than seven species, distributed in five genera. One at least of the coiled forms is exceptional for its spine-like appendages, a diversity in development, not heretofore observed in late Paleozoic nautiloids.

Among the ammonoids, *Perrinites hilli* (Smith) is predominant in its abundance and wide distribution in the Blaine and the Dog Creek formations. At two localities well preserved and all but complete living chambers of this species are common occurrences. Such fossil chambers, of importance in the ontogeny and ecological relationships of *Perrinites hilli* (Smith), have not heretofore been noted for the Blaine and the Dog Creek forms.

The faunas of the Blaine and the Dog Creek formations apparently represent limited if not sharply restricted continuities from those of early Permian. Many of the species are ubiquitous forms; other species of the faunas, for example the ammonoids, a few of the pelecypods and perhaps the brachiopods indicate relationships with Permian faunas elsewhere, and are therefore important in stratigraphic correlation.

The ammonoid *Perrinites hilli* (Smith), so abundant in Blaine and Dog Creek strata on the east side of the Permian basin, is correlated with *Perrinites* that occur in the upper Leonard series of western Texas. Similarly, a relationship to the San Andres group of New Mexico may be stated with only slightly less confidence, for the occurrence of *Perrinites* there is more than probable, if not certain. Of obvious importance in correlation is the fact that at least 23 of the invertebrate forms now recognized in the faunal assemblages on the east side of the basin, are known to occur in strata of the San Andres group of New Mexico, there in association with brachiopods regarded by Robert E. King as Leonard forms.

COLLECTING LOCALITIES

1. SE¼ Sec. 33, T. 15 N., R. 9 W., Kingfisher County, Oklahoma. *Perrinites* locality, Acme member of the Blaine.
2. Common line sections 19 and 30, T. 16, N., R. 10 W., Blaine County, Oklahoma.
   Perrinites locality; Acme member of Blaine.
3. Sec. 12, T. 7 N., R. 15 W., Kiowa County, Oklahoma.
   Perrinites locality; Acme member of Blaine formation.
4. NW¼ Sec. 6, T. 4 N., R. 23 W., Jackson County, Oklahoma.
5. An extensive area, including sections 148, 168, 169, 173, 198 and adjacent sections, north and northwest of Quanah, in Block H, of the Waco and NW. R. R. Company Survey, Hardeman County, Texas.
   A very important *Perrinites* locality; Acme member of Blaine.
6. Sections 217, 218, and adjacent areas, in Block H, of the Waco and NW. R. R. Company Survey, Hardeman County, Texas. This locality is about ten miles southwest of Quanah, Texas.
   Perrinites locality; Acme member of the Blaine.
7. Northeast Nolan County and Southeast Fisher County in Texas. Chiefly, Sec. 289, B. H. Stribling Survey, and Sec. 290, R. Cochran Survey.
   Perrinites locality; Acme member of the Blaine.
8. Section 15 and areas adjacent in T. 2 N., R. 25 W., about five miles southeast of Hollis, Harmon County, Oklahoma. Guthrie and Aspermont members of the Dog Creek.
9. Sections 410, 411, 420, and 421, northeast and southeast of Kirkland, in Childress County, Texas.
   Perrinites locality; Guthrie member of the Dog Creek formation.

TABLE 2.—LIST OF SPECIES IN BLAINE AND DOG CREEK FORMATIONS

The occurrence of these species in the San Andres of New Mexico (locality 13) and the Whitehorse of Oklahoma and Texas (locality 14) is included for comparison.

	LOCALITIES													
	Blaine							Dog Creek						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Crinoid stem segment										×			×	
Spirorbis sp.					×		×			×				×
Fistulipora sp.					×					×			×	
Polypora sp.										×				
Dictyoclostus bassi McKee										×			×	
Composita mexicana (Hall)										×			×	×
Edmondia rotunda Beede					×	×	×		×	×	×		×	×
Dozierella gouldii (Beede)?					×		×		×	×	×		×	×
Myalina apachesi Marcou				×	×	×	×		×	×	×		×	×
Pseudomonotis sublaevis Girty					×		×		×	×	×		×	
Pseudomonotis hawni (M & H)					×		×		×	×	×		×	×
Aviculopecten vanvleeti Beede					×		×		×	×				×
Aviculopecten girtyi Newell										×			×	
Allorisma rothi Newell	×	×	×	×	×		×		×	×	×	×	×	×
Schizodus oklahomensis Beede?	×	×	×	×	×	×		×	×	×	×		×	×
Schizodus texanum Clifton				×	×	×	×		×	×	×	×	×	
Nucula levatiformis (Walcott)					×		×			×			×	
Pleurophorus mexicanum Girty		×	×	×	×		×		×	×	×	×	×	
Pleurophorus albequus Beede	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Astartella subquadrata Girty					×					×			×	
Bellerophon majusculus Walcott					×		×		×	×	×		×	
Murchisonia gouldii Beede					×					×				×
Plagioglypta canna White					×	×	×		×	×			×	
Pseudorthoceras splendens Clifton					×		×		×	×				
Mooreoceras normale M. D & C.					×		×		×	×			×	
Mooreoceras gigantea Clifton					×				×	×			×	
Titanoceras sanandreasense M. D & C.					×		×		×	×	×		×	
Metacoceras inconspicuum Hyatt					×		×			×			×	
Coelogasteroceras mexicanum (Girty)					×		×		×	×	×		×	
Domatoceras sp. M & F					×					×			×	
Stenopoceras sp.					×					×				
Propinacoceras knighti M & F					×					×				
Medlicottia whitneyi Böse					×					×				
Medlicottia sp.					×					×				
Pseudogastrioceras texanum Clifton					×					×				
Adrianites newelli M & F										×				
Agathiceras girtyi Böse					×					×				
Perrinites hilli (Smith)	×	×	×		×	×	×		×	×	×	×		

10. Section 139 and areas northeast, in Block F, of the H. & T. C. R. R. Co. Survey, Stonewall County, Texas. The very important Croton Falls area is in Section 139.
Important *Perrinites* locality; Guthrie member of the Dog Creek.

10A. An area about three miles north, and extending to six miles north of Aspermont, Texas, in Stonewall County.
Perrinites locality; Guthrie member of the Dog Creek.

11. About two miles south of Sylvester, Fisher County, Texas.
Perrinites locality; Guthrie member of the Dog Creek.

12. About seven miles east and northeast of Sweetwater, Texas.
Perrinites locality; Guthrie member of the Dog Creek.

13. Southeast of Willard, New Mexico, and many other localities in New Mexico; San Andres group.

14. Localities of the unusual depositional features of the Whitehorse, in Texas and Oklahoma.

SYSTEMATIC DESCRIPTIONS

ECHINODERMATA

Class CRINOIDEA

CRINOID sp.
Plate 101, figure 1

Occurrence.—A single crinoid stem segment appears in the collections from the Croton Falls area, locality 10.

Figured specimen.—State University of Iowa.

VERMES

Genus SPIRORBIS Daudon

SPIRORBIS sp. Beede

Spirobis sp. BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 148, pl. 6, fig. 10.
Spirobis sp., NEWELL, *1940*, Geol. Soc. Am. Bull., vol. 51, p. 301.

Occurrence.—Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek, locality 10.

BRYOZOA

Genus FISTULIPORA McCoy

FISTULIPORA sp.
Plate 102, figure 9

This form is in the collections from two localities. Provisionally, the specimen might satisfactorily be referred to *F. grandis* var. *guadalupensis* Girty, yet there are discriminations by which the fossil might just as satisfactorily be referred to *F. nodulifera* Meek. No doubt the form is very close to the species described by Girty from the "dark limestone" of the Delaware Mountain area, in Texas. It is very probable that the Blaine and the Dog Creek form is a new species.

Occurrence.—Acme member of the Blaine at locality 5; Guthrie member of the Dog Creek, locality 10.

Figured specimen.—State University of Iowa.

Genus POLYPORA McCoy

POLYPORA sp.

This species appears in the collections from one locality, where its occurrence is rare. The specimen although badly preserved, is referred to the genus *Polypora* with some confidence.

Occurrence.—Guthrie member of the Dog Creek formation at locality 10.

BRACHIOPODA

Genus PRODUCTUS Sowerby

PRODUCTUS (DICTYOCLOSTUS) BASSI McKee
Plate 102, figures 14, 15

Productus semireticulatus NEWBERRY, *1861*, Rept. upon Colo. River of the West exp. by Lieut. Ives, p. 124.
Productus semireticulatus ivesii WHITE (part), *1877*, U. S. Geog. Survey, W. 100th Mer. Rept., vol. 4, p. 11–113, pl. 8, figs. 1a, b, e.
Productus ivesii?, HALL and WHITFIELD, *1877*, U. S. Geol. Exploration of the fortieth parallel, Paleontology, vol. 4, pt. 2, p. 67–68, pl. 7, figs. 6, 6a, 6b.
Productus ivesi, GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 56.
Productus ivesi, KING, *1930*, Texas Univ. Bull. 3042, pt. 2, p. 65–70, pl. 12, figs. 1–6.
Dictyoclostus bassi McKEE, *1938*, Carnegie Institution Washington; pub. 492, pt. 2, p. 234–239, pl. 45, figs. 1, 2.

A single specimen is in the collections from one locality. The form is weathered, broken, and otherwise badly preserved, yet the points upon which discrimination is made are definite. The faint costae and rugae, the large hollow or tubular spines and spine bases compare closely with forms in the collections from the San Andres group of New Mexico.

Occurrence.—The Guthrie member of the Dog Creek, locality 10.

Hypotype.—State University of Iowa.

Genus COMPOSITA Brown
COMPOSITA MEXICANA (Hall)
Plate 102, figures 16, 17

Terebratula mexicana HALL, *1857*, in Emory, U. S. and Mexican Boundary Survey Report, vol. 1, pt. 2, pl. 20, fig. 2.
Composita mexicana, GIRTY, *1908*, U. S. Geol. Survey, Prof. Paper 58, p. 389–390.
Composita mexicana var. *guadalupensis* GIRTY, *1908*, U. S. Geol. Survey, Prof. Paper 58, p. 390, pl. 24, figs. 11–13b.
Composita mexicana, GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 68, pl. 8, fig. 1.
Composita mexicana, KING, *1930*, Texas Univ. Bull. 3042. p. 128–129, pl. 43, figs. 1–11.

This species is in the collections from one locality, where its occurrence is scarce. The species is in the collections from the San Andres of New Mexico, and from the unusual depositional features of the Whitehorse in Oklahoma and Texas.

Occurrence.—Guthrie member of the Dog Creek, locality 10.

Hypotypes.—State University of Iowa.

MOLLUSCA

Class PELECYPODA
Genus EDMONDIA de Koninck
EDMONDIA ROTUNDA Beede
Plate 102, figures 5–7

Edmondia rotunda BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 150, pl. 7, figs. 3, 3b.
Edmondia cumminsi BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 151, pl. 7, figs. 4, 4a.
Edmondia rotunda, NEWELL, *1940*, Geol. Soc. Am. Bull., vol. 51, p. 281, pl. 2, figs. 18–21.

Molds and casts of specimens in the collections agree rather closely with Beede's forms from the Whitehorse.

Occurrence.—The species is relatively common to the Blaine and the Dog Creek formations. Acme member of the Blaine at localities 5, 6, and 7; Guthrie member of the Dog Creek at localities 9, 10, and 11.

Hypotypes.—State University of Iowa.

Genus DOZIERELLA Newell
DOZIERELLA GOULDII (Beede)?
Plate 102, figure 8

Bakevellia parva WHITE, *1877*, U.S. Geog. Survey, W. 100th Mer. Rept., vol. 4, p. 153, pl. 11, figs. 7a–b.
Bakewellia gouldii BEEDE, *1902*, Oklahoma Geol. Survey, 1st Bienn. Rept. Advance Bull., p. 5, pl. 1, figs. 2–2c.
Cyrtodontarca? gouldii, BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 152, pl. 6, figs. 1–1e.
Dozierella gouldii, NEWELL, *1940*, Geol. Soc. Am. Bull., vol. 51, p. 282–285, pl. 1, figs. 14–22.

Poorly preserved molds and casts of this species are in the collections from several localities. The specimens are not so robust as those described from the Whitehorse.

Occurrence.—Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek, localities 9, 10, and 11. Scarce to rare.

Homeotype.—State University of Iowa.

Genus MYALINA de Koninck
MYALINA APACHESI Marcou
Plate 101, figures 17, 18
Plate 102, figures 3, 4

Myalina apachesi MARCOU, *1858*, Geol. North America, p. 44, pl. 7, figs. 6, 6a.
Myalina apachesi GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 81, pl. 9, figs. 6, 7.

This species is not abundant at any locality but appears to have wide range, laterally and vertically. Girty has noted this form from localities in New Mexico and it is in the present collections from the San Andres of New Mexico.

Occurrence.—Acme member of the Blaine at localities 4, 5, 6, and 7; Guthrie member of the Dog Creek, localities 9, 10, and 11.

Hypotypes.—State University of Iowa.

Genus PSEUDOMONOTIS Beyrich
PSEUDOMONOTIS SUBLAEVIS Girty
Plate 103, figure 7

Pseudomonotis sublaevis GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 80, pl. 9, figs. 1–3.
Pseudomonotis sublaevis, NEWELL, *1937*, Kansas Geol. Survey, vol. 10, p. 95, pl. 18, figs. 17, 18.

This species is common to the Blaine and the Dog Creek, and at one locality in northeastern Nolan County, Texas, the natural casts and molds occur in abundance, such that as many as ten individuals have been collected from a small block of limestone. The species is in the collection from localities of the San Andres of New Mexico.

Occurrence.—Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek at localities 9, 10, and 11.

Hypotype.—State University of Iowa.

PSEUDOMONOTIS HAWNI
(Meek and Hayden)
Plate 101, figure 31

Monotis hawni MEEK and HAYDEN, *1858*, Albany Inst., Trans., vol. 4, p. 76.
——, *1859*, Phila. Acad. Nat. Sci., PROC., p. 28.

Eumicrotis hawni, MEEK and HAYDEN, *1864*, Paleontology Upper Missouri, p. 54, pl. 2, figs. 5a–c; var. *ovata*.
——, *1864*, idem, p. 55, pl. 2, figs. 5a, b.
Pseudomonotis hawni BEEDE, *1900*, Kansas Univ. Geol. Survey Rept., vol. 6, p. 132, pl. 13, figs. 11–11c; pl. 15, 1–1f, 2, 2a.
Pseudomonotis hawni, GIRTY, *1903*, U. S. Geol. Survey, Prof. Paper 16, p. 427.
——, *1909*, U. S. Geol. Survey, Bull. 389, p. 79, pl. 9, fig. 4.
Pseudomonotis hawni, NEWELL, *1937*, Kansas Geol. Survey, vol. 10, p. 94, pl. 17, figs. 11a, b; pl. 18, figs. 8–16.

The species, although present at several localities of the Blaine and the Dog Creek, is rare. The natural casts and molds are poorly preserved. A single form is in the collections that shows typical radiating costae, from the more prominent of which rise regularly placed spine-like protuberances and projecting, lamellar-like growths. The species is in the collections from the San Andres of New Mexico and from one locality of the Whitehorse in Texas.

Occurrence.—Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek, localities 9, 10, and 11.

Homeotype.—State University of Iowa.

Genus AVICULOPECTEN McCoy, emend. NEWELL

AVICULOPECTEN VANVLEETI Beede

Aviculopecten vanvleeti BEEDE, *1902*, Oklahoma Geol. Survey, 1st Bienn. Rept., Advance Bull., p. 6, pl. 1, figs. 8–8b.
Aviculopecten vanvleeti BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 158, pl. 5, figs. 3–3c; pl. 6, figs. 11–11c.
Aviculopecten vanvleeti NEWELL, *1937*, Kansas Geol. Survey, vol. 10, p. 57, pl. 5, figs. 8–10.
——, *1940*, Geol. Soc. Am. Bull., vol. 51, p. 293, pl. 2, figs. 14–17.

Occurrence.—A few poorly preserved specimens were collected at four localities. Acme member of the Blaine, localities 5 and 7; Guthrie member of the Dog Creek, localities 9 and 10.

Genus ALLORISMA King

ALLORISMA ROTHI Newell

Plate 101, figures 2, 3

Solenomya sp. BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 150, pl. 5, fig. 4.
Allorisma rothi NEWELL, *1940*, Geol. Soc. Am., vol. 51, p. 296, pl. 2, figs, 5, 6.

This form is in the collections from many localities of the Blaine and the Dog Creek formations. Its occurrence is common to the Cedar Top, the Acme and the Shimer members of the Blaine in Oklahoma and Texas. The species is in the collections from the San Andres of New Mexico and the Whitehorse of Oklahoma and Texas.

Occurrence.—Common to the Blaine in Oklahoma and Texas; common to the Guthrie, and the Aspermont members of the Dog Creek, localities 9, 10, 11, and 12.

Homeotypes.—State University of Iowa.

Genus SCHIZODUS King

SCHIZODUS OKLAHOMENSIS (Beede)?

Plate 101, figures 13–16

Schizodus oklahomensis BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 157, pl. 7, fig. 6.
Schizodus oklahomensis NEWELL, *1940*, Geol. Soc. Am., Bull., 51, pp. 281–293, pl. 1, figs. 1–6.
Schizodus ovatus? BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 157, pl. 7, figs. 7–7b.

This species is common to the Blaine and the Dog Creek formations at many localities, and is very abundant in outcrops of the Aspermont member of the Dog Creek in Texas, where well preserved natural casts of many individuals compose a large part of the rock mass. The species is in the collections from the San Andres of New Mexico, and from the Whitehorse of Oklahoma and Texas.

Occurrence.—Common to most members of the Blaine and the Dog Creek at many localities in Oklahoma and Texas.

Hypotypes.—State University of Iowa.

SCHIZODUS TEXANUS Clifton, n. sp.

Plate 101, figures 20–28;
Plate 102, figures 10–13

Schizodus wheeleri WHITE, *1877*, U. S. Geog. Survey, W. 100th Mer., Rept., vol. 4, p. 154, pl. 11, figs. 6a, b.
Schizodus wheeleri GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 82–84, pl. 10, fig. 6.

Shell of moderate size, relatively thick, subtriangular to subquadrate in outline; elongated posteriorly, laterally compressed and laterally wedge-shaped; much inflated anteriorly, with greatest convexity below the beaks. Anterior margin is semicircular; ventral margin is elliptical and evenly convex, and posteriorly turns abruptly upward and forward at an angle of about 45 degrees to meet the downward and backward sloping posterior margin. The dorsal margin is

nearly straight, inclined slightly downward and meets the dorsal-posterior margin, not at an obtuse angle but in a low arcuate convexity; posterior margin is approximately convex rather than truncate.

The umbonal area is somewhat elevated and posteriorly forms a slightly rounded but not distinct ridge that ends in the angle of the shell extremity. The beaks are prominent, incurved, slightly opisthogyrate and placed a little less than one-third of the shell length behind the anterior margin. Shell surface is marked by distinct concentric striae or elevated ridges, regularly spaced about nine in five millimeters on the mature shell.

Each valve in the mature individual has two cardinal teeth of unequal size, none of which is bifid, fluted, or striated. The left valve of the immature shell has usually an indistinct third posterior cardinal tooth, or ridge-like undulation on the hinge plate behind the large second cardinal tooth. This third cardinal tooth is lacking or obsolescent in the mature left valve.

In the right valve there is a large anterior cardinal tooth placed at the front of the beak, and a smaller posterior cardinal tooth placed slightly behind the beak. The large anterior tooth is approximately rounded, expands gradually outward and is largest near its extremity; extends slightly forward and obliquely downward, and is indistinctly or not at all bilobed. The smaller posterior cardinal tooth is somewhat rounded, or even slightly lamellar and extends backward and downward with the shell margin. Distinct cavities or depressions at the hinge plate, one in front and one behind the large anterior tooth, receive respectively the smaller anterior tooth and the large posterior tooth of the left valve.

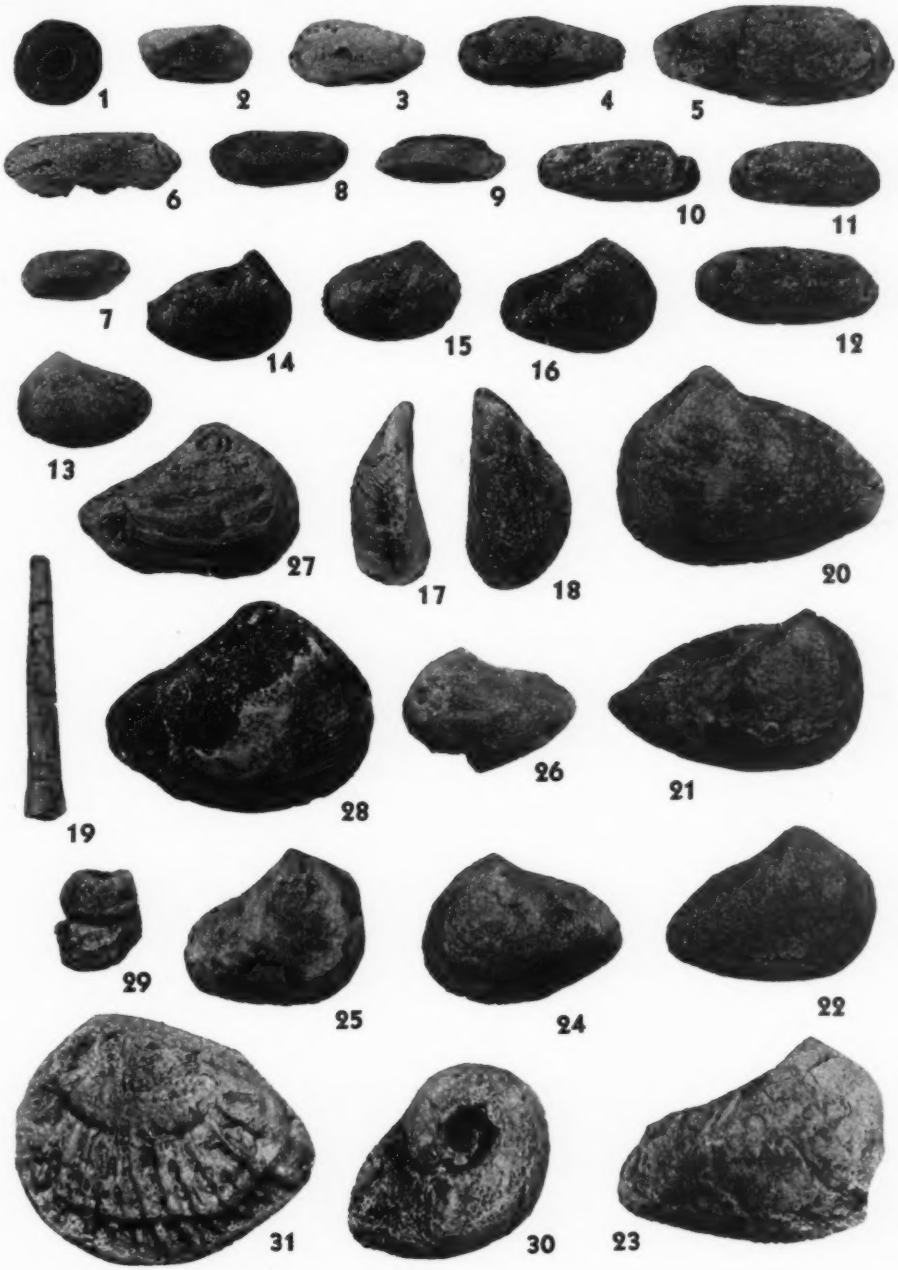
In the left valve there is a small anterior cardinal tooth placed well in front of the beak, and a large conspicuous posterior cardinal tooth placed central with the beak. The smaller anterior tooth appears to be rounded but may be lamellar or even angulate in better material, and extends obliquely forward, parallel to the hinge line. The large posterior cardinal tooth is rounded to wedge-shaped and is faintly bilobed. Cavities or depressions on the hinge plate, in part outlined by the dentition, one in front and one behind the large posterior cardinal tooth receive respectively, the large anterior and the smaller posterior cardinal tooth of the right valve.

Shell measurements based upon natural casts and molds, for many specimens fall within the following limits; length of shell, 35 to 47 millimeters; height of shell, from top of beak to basal margin, 24 to 35 millimeters; valve convexity; 7 to 16 millimeters.

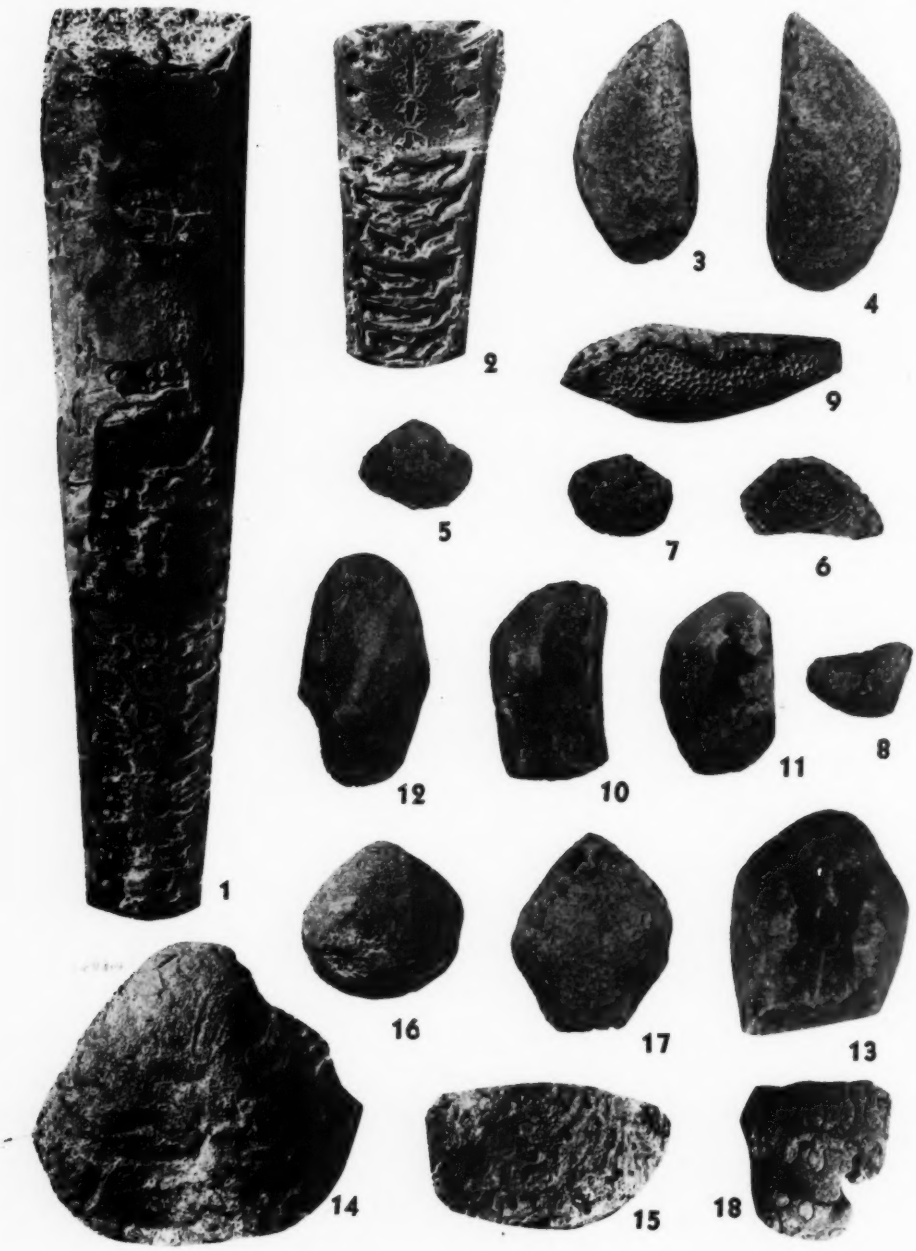
EXPLANATION OF PLATE 101

All figures are natural size. The specimens illustrated are deposited at the State University of Iowa.

FIGS. *1*—Crinoid stem segment from locality 10. (p. 689)
2–3—*Allorisma rothi* Newell. Right and left valves from locality 4. (p. 691)
4–5—*Pleurophorus mexicanus* Girty. *2*, Left valve of natural cast, locality 3; *3*, Right valve, locality 5. (p. 693)
6–12—*Pleurophorus albequus* Beede. *6*, *7*, *8*, Right valves, locality 4; *9*, Right valve, locality 10; *10*, Right valve, locality 5; *11*, *12*, Right and left valves for comparison from the Whitehorse sandstone. (p. 693)
13–16—*Schizodus oklahomensis* Beede. *13*, Left valve of specimen from the Aspermont member of the Dog Creek, at locality 10; *14*, *15*, View of right valves, locality 10; *16*, Right valve of specimen from the Whitehorse, for comparison. (p. 691)
17–18—*Myalina apachesi* Marcou. *17*, A bivalved specimen, locality 7; *18*, View of specimen for comparison from Whitehorse sandstone. (p. 690)
19—*Plagioglypta canna* White. A specimen from locality 5. (p. 694)
20–28—*Schizodus texanus* Clifton, n. sp. *20*, Left valve of holotype, a bivalved natural internal mold from locality 5; *21–23*, Right valves of paratypes, from locality 5; *24–27*, Right and left valves of paratypes, from locality 10; *28*, Right valve of paratype, from the San Andres of New Mexico. (p. 691)
29—*Murchisonia gouldii* Beede. A broken natural mold from locality 5. (p. 694)
30—*Bellerophon majusculus* Walcott. Small weathered natural mold, from locality 7. (p. 694)
31—*Pseudomonotis hawni* (Meek and Hayden). A broken specimen from locality 10. (p. 690)



Clifton, Permian Invertebrates



Clifton, Permian Invertebrates

Occurrence.—Acme member of the Blaine at localities 4, 5, 6, and 7; Guthrie member of the Dog Creek at localities 9, 10, 11, and 12. Common at most localities; abundant at locality 5, northwest of Quanah, Texas. This species is in the collections from the San Andres group of New Mexico.

Holotype and paratypes.—State University of Iowa.

Genus NUCULA Lamarck
NUCULA LEVATIFORMIS Walcott

Nucula levatiforme WALCOTT, *1884*, U. S. Geol. Survey, Mon. 8, p. 241, pl. 22, figs. 1, 1a.
Nucula levatiformis GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 74, pl. 10. figs. 7, 8.

Occurrence.—Fragmentary specimens that show dentition, are in the collections from the Acme member of the Blaine, locality 5; the Guthrie member of the Dog Creek, locality 10. Rare.

Genus PLEUROPHORUS King
PLEUROPHORUS MEXICANUS Girty
Plate 101, figures 4, 5

Pleurophorus mexicanum GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 91, pl. 10, fig. 1.

Occurrence.—Acme member of the Blaine at localities 2, 3, 4, 5, and 7; Guthrie member of the Dog Creek at localities 9, 10, 11, and 12. Rare to common.

Hypotype.—State University of Iowa.

PLEUROPHORUS ALBEQUUS Beede
Plate 101, figures 6–12

Pleurophorus sp. BEEDE, *1902*, Oklahoma Geol. Survey, 1st Bienn. Rept., Advance Bull., p. 9, pl. 1, fig. 4.
Pleurophorus? albequus BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 160, pl. 6, figs. 8–8e.
Pleurophorus albequus NEWELL, *1940*, Geol. Soc. Am., Bull. 51, p. 298, pl. 3, figs. 1, 4–8, 14, 16–18.

Occurrence.—*Pleurophorus albequus* Beede is common to most members of the Blaine and the Dog Creek in Oklahoma and Texas. The species occurs in the limited numbers at one locality of the Blaine in Kansas. *P. albequus* is in the collections from a locality about seven miles southwest of San Angelo, Texas. Here the species occurs in association with *Schizodus oklahomensis* Beede in beds that have been described as the San Angelo formation. It is now believed that at this locality the fossil occurrence is in the Blaine instead of the San Angelo formation.

Hypotype.—State University of Iowa.

Genus ASTARTELLA Hall
ASTARTELLA SUBQUADRATA Girty

Astartella subquadrata GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 94, pl. 10, figs. 10–13.

Occurrence.—Poorly preserved natural casts of this species are rare in the collections from the Acme member of the Blaine at locality 5.

EXPLANATION OF PLATE 102

All figures ×2. The specimens illustrated are deposited at State University of Iowa.

FIGS. *1, 2—Pseudorthoceras splendens* Clifton, n. sp. *1*, Holotype, partly sectioned, to show internal relationships, locality 10; *2*, View of sectioned portion of a paratype showing camerae siphonal deposits and septal walls, locality 10. (p. 694)
3, 4—Myalina apachesi Marcou. Views of right and left valves, locality 10. (p. 690)
5–7—Edmondia rotunda Beede. *5, 7*, Internal natural molds of valves from locality 5; *6*, External natural mold, locality 5. (p. 690)
8—Dozierella gouldii (Beede), A broken left valve, locality 9. (p. 690)
9—Fistulipora sp. An external aggregate, from locality 10. (p. 689)
10–13—Schizodus texanus Clifton, n. sp. *10, 11*. Dorsal views of left valves of paratypes, showing dentition areas, locality 5; *12*. Dorsal view of right valve, of paratype, showing part of dentition, locality 5; *13*, Dorsal view of bivalved paratype, showing part of dentition, locality 5. (p. 691)
14, 15—Productus (*Dictyoclostus*) *bassi* McKee. *14*, View of internal natural mold of pedicle valve, showing faint costate, concentric rugae, and a portion of the medial sinus, locality 10; *15*, A portion of an external natural mold of pedicle valve, showing the tubular spines and large spine bases, locality 10. (p. 689)
16, 17—Composita mexicana (Hall). View of broken pedicle valve, locality 10; *17*, View of brachial valve, of specimen from locality 10. (p. 690)
18—Adrianites newelli Miller and Furnish. View of ventral area, showing suture lines for a broken specimen, from locality 10. (p. 698)

GASTROPODA
Genus BELLEROPHON Montfort
BELLEROPHON MAJUSCULUS Walcott
Plate 101, figure 30

Bellerophon majusculus WALCOTT, *1884*, U. S. Geol. Survey Mon. 8, p. 256, pl. 23, figs. 1, 1a; pl. 24, fig. 6.
Bellerophon majusculus GIRTY, *1909*, U. S. Geol. Survey Bull. 389, p. 101, pl. 11, fig. 2.

Poorly preserved natural casts and molds in the collections are referred to this species with some reservation. Better material is needed for definite discrimination between *B. majusculus* and *B. crassus*. However, the point upon which discrimination is made agrees with that for *B. majusculus*. The species is in the collections from the San Andres of New Mexico.

Occurrence.—Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek at localities 9, 10, and 11. The form is abundant at locality 7. Scarce to common at other localities.

Hypotype.—State University of Iowa.

Genus MURCHISONIA d'Archaic and de Vernueil
MURCHISONIA GOULDII Beede
Plate 101, figure 29

Murchisonia gouldii BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 167, pl. 8, figs. 6, 6a, 6b.
Murchisonia collingsworthensis BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 166, pl. 8, figs. 7, 7a.
Orthonema? texana BEEDE, *1907*, Kansas Univ. Sci. Bull., vol. 4, p. 168, pl. 8, figs. 5, 5a.
Murchisonia gouldii KNIGHT, *1940*, in Newell, Geol. Soc. Am. Bull., vol. 51, p. 306–309, pl. 5, figs. 1–14; pl. 6, figs. 1a–e.

Occurrence.—Acme member of the Blaine at locality 5; Guthrie member of the Dog Creek at locality 10. Scarce to rare.

Hypotype.—State University of Iowa.

Class SCAPHOPODA
Genus PLAGIOGLYPTA Pilsbry
PLAGIOGLYPTA CANNA White
Plate 101, figure 19

Dentalium canna WHITE, *1874*, U.S. Geog. Survey W. 100th Mer. Prel. Rept. Inv. Foss., p. 23.
——, *1877*, idem. vol. 4, p. 156, pl. 12, figs. 6a, b.
Plagioglypta canna GIRTY, *1903*, U. S. Geol. Survey, Prof. Paper 16, p. 452;
——, *1908*, U. S. Geol. Survey, Prof. Paper 58, p. 450, pl. 23, figs. 11–13.
——, *1909*, U. S. Geol. Survey, Bull. 389, p. 95, pl. 11, fig. 11.

Occurrence.—Acme member of the Blaine at localities 5, 6, and 7; Guthrie member of the Dog Creek at localities 9 and 10. Scarce to common.

Hypotype.—State University of Iowa.

Class CEPHALOPODA
Order NAUTILOIDEA Zittel
Genus PSEUDORTHOCERAS Girty
PSEUDORTHOCERAS SPLENDENS
Clifton, n. sp.
Plate 102, figures 1, 2;
Plate 103, figure 1

The conch is long, slender, circular or nearly so in cross section, conspicuously and regularly expanded adorally. The initial stages and living chamber are not known. The test of the phragmacone is relatively thin, its surface apparently unmarked; its internal mold marked by sutures that are approximately circles and lie in a plane directly transverse to the long axis of the conch. The septa are simple convex disks, whose convexity adapically is about one-fifth of their diameter. The length of the camerae in neanic and older individuals increases slightly adorally, but not regularly so. The camerae are spaced such that four to six of them occupy a length equal to the diameter on the conch at point of measurement.

The siphuncle is not known in the initial stages of the conch but in the rest of the phragmacone it is central in position and parallel to the long axis of the conch. The siphuncle, at its passage through the septa, is constricted, and funnel-shaped. But just beyond the passage through the septa, the siphuncle rapidly expands within the camerae into subspherical segments with inner or siphonal walls and outer or subspherical walls. These expanded segments adapically are pyriform rather than subspherical, but soon adorally become subspherical, and at all positions are abruptly rounded adorally; the maximum diameter of the expanded segments of the siphuncle approximate one-fourth of that for the phragmacone and lies slightly adoral to the midlength of the camerae. The connecting rings or outer walls of the expanded segments of the siphuncle adapically are in contact with the septa, but adorally are not in such contact outside of the septal necks. The septal necks

are short, strongly recurved, their length but slightly less than one-third the diameter of the septal foramen, which in turn is equal in diameter to one-fifteenth of that for the phragmacone.

The walls of the camerae like the walls of the expanded segments of the siphuncle, are lined by deposits that do not completely fill the chambers; such deposits are usually lamellar, but vary and may be dense aggregates that approximate lamellar structure and symmetry.

Occurrence.—The Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek at localities 9 and 10. Common at these localities.

Holotype and paratypes.—State University of Iowa.

Genus MOOREOCERAS Miller, Dunbar and Condra
MOOREOCERAS NORMALE Miller, Dunbar and Condra
Plate 103, figure 2

Orthoceras colletti MORSE, *1931*, Kentucky Geol. Survey, ser. 6, vol. 36, p. 300, 325–326, pl. 54, figs. 1, 2.
Mooreoceras normale MILLER, DUNBAR and CONDRA, *1933*, Nebraska Geol. Survey, 2nd. ser. p. 87, pl. 2, figs. 5–7.

Occurrence.—Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek at localities 9, 10, and 11. Common at locality 5, abundant at locality 10.

Hypotype.—State University of Iowa.

MOOREOCERAS GIGANTEA Clifton, n. sp.
Plate 103, figures 4–6

Except for two important differences this species is very like other forms that have been generally assigned to the genus "Orthoceras." The unusually large size attained by individuals and the position of the siphuncle are of specific rank for this middle Permian cephalopod. The position and structure of the siphuncle and the shape of its segments are characters on which a satisfactory assignment to *Mooreoceras* may be made.

The conch is long, straight, gradually and regularly expanded adorally, and is subcircular to elliptical in cross section. The holotype, an internal mold, is depressed, due in part perhaps to distortion during preservation. The phragmacone of the holotype is represented by nineteen camerae that have a length of 130 millimeters. The adapical diameter increases from about 35 millimeters to about 58 millimeters near the adoral end. The living chamber of the holotype is not known but in smaller individuals, fragmentary living chambers appear to be long, gradually and regularly expanded in degree very like their phragmacones.

The test appears to be relatively thick, the internal mold is unmarked except for suture lines, and the conch apparently is devoid of sculpturing.

The septa are simple convex disks, whose adapical convexity is about one-fourth of their diameter. The suture lines are transverse to the long axis of the conch and are essentially straight except for dorsal and ventral sinuous flexures—slight, regular, and very shallow deviations from a transverse plane. About six septal chambers or camerae occur in a length equal to the diameter of the phragmacone at point of measurement. For the mature phragmacone, this ratio is rather constant and is independent of position on it.

The siphuncle is distinctly ventral of the center of the conch, and at its passage through the septa is small but is expanded within the camerae. The septal necks are short and recurved. The segments of the siphuncle are essentially fusiform to slightly pyriform, the segments being more nearly rounded adorally than adapically. The septal necks of the siphuncle only are in contact with the septa.

Measurements of the phragmacone of the holotype indicate a maximum diameter of more than 68 millimeters, and a length greater than 225 millimeters, exclusive of the living chamber; its regular and gradual increase adorally in diameter is about 13 millimeters for an axial distance of 60 millimeters. The length of its camerae is relatively small; the segments of the siphuncle are only moderately expanded within the camerae. The siphuncle is placed ventral to the long axis of the conch, and is distinctly eccentric.

Occurrence.—Acme member of the Blaine at localities 5 and 7; Guthrie member of the Dog Creek at localities 9 and 10. Common to localities 5 and 10.

Holotype and paratype.—State University of Iowa.

Genus TITANOCERAS Hyatt
TITANOCERAS SANANDREASENSE Miller, Dunbar and Condra

Titanoceras sanandreasense MILLER, DUNBAR and CONDRA, *1933*, Nebraska Geol. Survey, Bull. 9, 2nd. ser., p. 204, pl. 13, fig. 7; pl. 17, figs. 1–2.

This species is common to the Blaine and the Dog Creek formations at several localities, and at the locality near Quanah, Texas, some specimens attain a large size, being more than 240 millimeters in diameter.

Occurrence.—Acme member of the Blaine, localities 5 and 7; Guthrie member of the Dog Creek, localities 9, 10, and 11.

Genus METACOCERAS Hyatt
METACOCERAS INCONSPICUUM Hyatt

Metacoceras inconspicuum HYATT, *1891*, Texas Geol. Survey, Ann. Rept. 2, p. 340–341, text figs. 40, 41.
Metacoceras inconspicuum HAY, *1893*, Kansas Acad. Sci. Trans., vol. 13, p. 38, 41–42, text figs. 10, 11.
Metacoceras inconspicuum GIRTY, *1915*, U. S. Geol. Survey, Bull. 544, p. 239.
Metacoceras inconspicuum MILLER, DUNBAR and CONDRA, *1933*, Nebraska Geol. Survey, Bull. 9, 2nd. ser., p. 181–184, text figs. 29, 30.

Specimens of the genus *Metacoceras* occur in the Blaine and the Dog Creek formations. Some of the forms attain a relatively large size, being as much as 130 millimeters in diameter. The assignment of these specimens to *M. inconspicuum* is not an entirely satisfactory one. The Blaine and the Dog Creek forms may be a new species.

Occurrence.—Acme member of the Blaine, localities 5 and 7; Guthrie member of the Dog Creek, locality 10. Common at these localities.

Genus COELOGASTEROCERAS Hyatt
COELOGASTEROCERAS MEXICANUM (Girty)
Plate 103, figure 3

Coloceras mexicanum GIRTY, *1909*, U. S. Geol. Survey, Bull. 389, p. 113, pl. 12, fig. 1.
Coelogasteroceras mexicanum MILLER, DUNBAR and CONDRA, *1935*, Nebraska Geol. Survey, Bull. 9, 2nd. ser., p. 212.

Occurrence.—Acme member of the Blaine, localities 5 and 7; Guthrie member of the Dog Creek, localities 9, 10, and 11.

Hypotype.—State University of Iowa.

Genus DOMATOCERAS Hyatt
DOMATOCERAS sp.

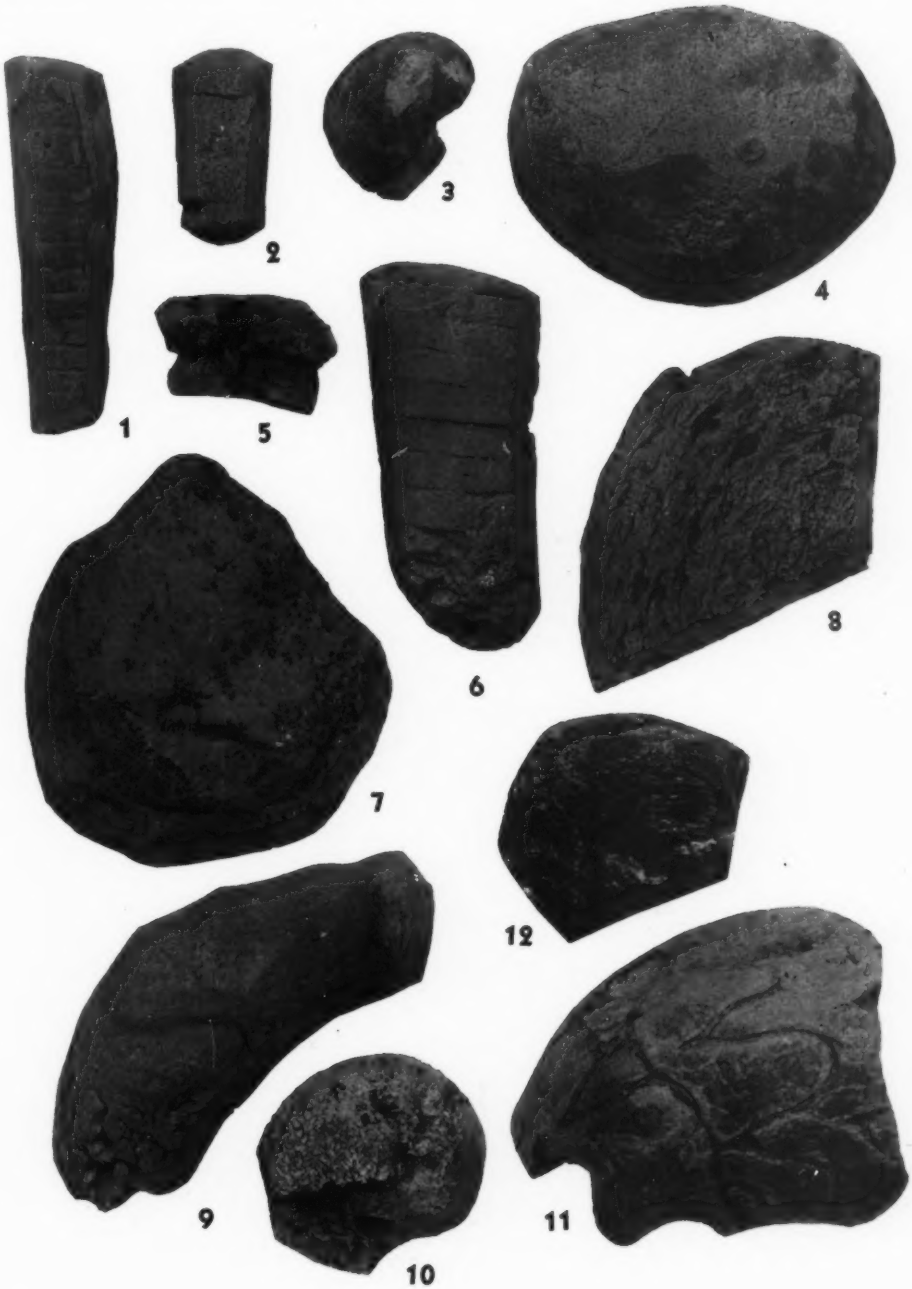
In the collections there are several specimens, which no doubt are properly assigned to the genus *Domatoceras*. The specimens may represent a new species. They are hardly to be confused with *Stenopoceras*, which is also present at the same localities.

Occurrence.—Acme member of the Blaine, at localities 5 and 7; Guthrie member of the Dog Creek, locality 10. Scarce to common.

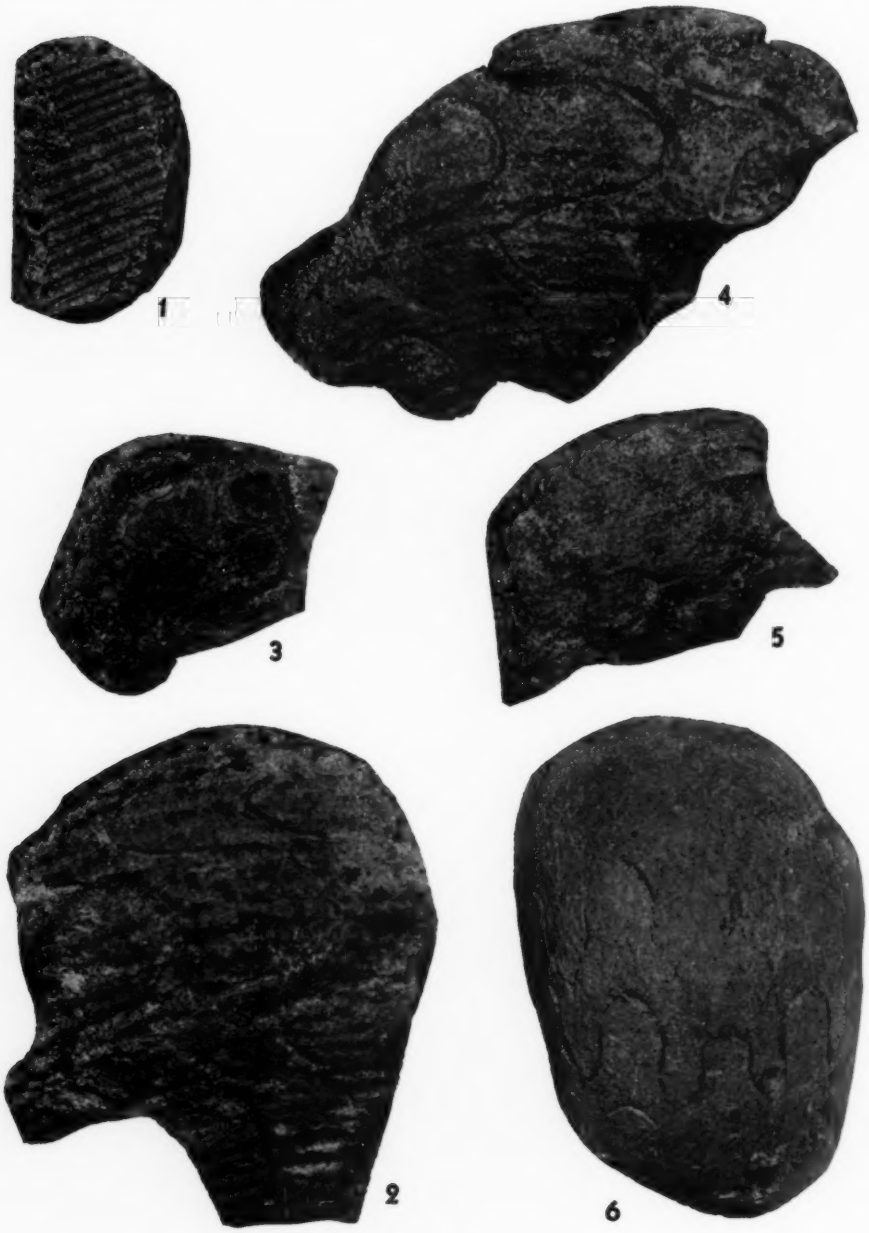
EXPLANATION OF PLATE 103

The specimens illustrated are deposited at State University of Iowa.

FIGS. *1*—*Pseudorthoceras splendens* Clifton, n. sp. A paratype, ×1, showing portion of phragmacone from locality 10. (p. 694)
2—*Mooreoceras normale* Miller, Dunbar and Condra. Portion of phragmacone, ×1, from locality 10. (p. 695)
3—*Coelogasteroceras mexicanum* Girty. A small specimen, ×1, from locality 5. (p. 696)
4–6—*Mooreoceras gigantea* Clifton, n. sp. *4*, An adapical view of a septal chamber of the holotype, ×1, showing position of siphuncle of a specimen from locality 5; *5*, Sectioned camerae of holotype, ×1, showing segment of siphuncle and siphonal walls; *6*, View of phragmacone of a paratype, ×1, from locality 10. (p. 695)
7—*Pseudomonotis sublaevis* Girty. Valve of weathered specimen, ×1, showing faint shell markings, from locality 7. (p. 690)
8—*Medlicottia whitneyi* Böse. Lateral view of a broken specimen, ×1, from locality 5. (p. 697)
9, 10—*Perrinites hilli* (Smith). *9*, Ventral-lateral view of a portion of living chamber attached to the phragmacone, ×1, a specimen from locality 10; *10*, Lateral view of the inner volutions of an Oklahoma specimen, ×1, showing suture lines; locality 1. (p. 698)
11, 12—*Pseudogastrioceras texanum*, Clifton, n. sp. *11*, Ventral-lateral view of the holotype, ×1, showing suture lines, constriction line, and faint longitudinal lirae; a specimen from locality 5; *12*, Portion of an inner volution of the holotype, ×2, showing longitudinal lirae. (p. 697)



Clifton, Permian Invertebrates



Clifton, Permian Invertebrates

AMMONOIDEA

Genus PROPINACOCERAS Gemmellaro, 1887

PROPINACOCERAS KNIGHTI

Miller and Furnish

Propinacoceras knighti MILLER and FURNISH, *1940*, Geol. Soc. America Spec. Paper 26, p. 42–44, pl. 5, figs. 1–4; pl. 6, fig. 7.

Fragmentary specimens are in the collections from two localities. The type of material is not such that discrimination may be made with confidence, yet the poorly preserved forms are comparable with the species described by Miller and Furnish.

Occurrence.—Acme member of the Blaine, locality 5; Guthrie member of the Dog Creek, locality 10. Rare at both localities.

Genus MEDLICOTTIA Waagen

MEDLICOTTIA WHITNEYI Böse

Plate 103, figure 8

Medlicottia sp. SMITH, *1903*, U. S. Geol. Survey, Mon. 42, p. 141.

Medlicottia copei? BÖSE, *1917*, Texas Univ. Bull. 1762, p. 25.

Medlicottia whitney BÖSE, *1917*, Texas Univ. Bull. 1762, p. 18, 34, 35, 71–76, 199, 201, pl. 1, figs. 41–45.

Eumedlicottia crotonensis PLUMMER and SCOTT, *1937*, Texas Univ. Bull. 3701, p. 19, 21, 82–84, 85, 398, pl. 6, figs. 7–11.

Eumedlicottia whitneyi PLUMMER and SCOTT, *1937*, Texas Univ. Bull. 3701, p. 23, 24, 32, 82, 84–85, pl. 5, figs. 12, 13.

Medlicottia whitneyi MILLER and FURNISH, *1940*, Geol. Soc. America, Spec. Paper 26, p. 55–57, pl. 6, fig. 6; pl. 8, figs. 5, 6; pl. 10, figs. 4, 5.

Occurrence.—Acme member of the Blaine at locality 5; Guthrie member of the Dog Creek at locality 10. Common in occurrence.

Hypotype.—State University of Iowa.

Genus MEDLICOTTIA Waagen

MEDLICOTTIA sp.

In the collections there are many badly preserved specimens of the genus *Medlicottia* not wholly comparable with species previously described in the literature. Such specimens no doubt represent a new species, yet the material at hand is such that description may not be critically made and better material is awaited.

Occurrence.—Acme member of the Blaine at locality 5; Guthrie member of the Dog Creek at locality 10. Scarce to common.

Genus PSEUDOGASTRIOCERAS Spath

PSEUDOGASTRIOCERAS TEXANUM

Clifton, n. sp.

Plate 103, figures 11, 12,

Plate 104, figures 1–6

The conch is subdiscoidal and the phragmacone attains a diameter of about 130 millimeters. The whorls of the phragmacone are broadly rounded ventrally, only slightly rounded laterally, and depressed dorsally. The holotype represented by figures 11 and 12, on plate 103, has a diameter of 105 millimeters; its height near the adoral end of the conch is about 40 millimeters and its width is 48 millimeters. Corresponding measurements for other individuals in the collections exhibit similar ratios for diameter, height, and thickness, respectively.

The umbilicus is relatively large, the umbilical shoulders are rounded but sharply defined, and the umbilical walls are steep.

The surface ornamentation of the conch is a chief basis for discrimination of the spe-

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EXPLANATION OF PLATE 104

All figures ×2. The specimens illustrated are deposited at State University of Iowa.

FIGS. *1–6—Pseudogastrioceras texanum* Clifton, n. sp. *1*, External natural mold of a paratype, showing longitudinal ribs in the ventral-lateral area. The space portrayed is equal to about one-fourth of the surface distance along a line of diameter for the outer whorl. Diameter of specimen from ventor to ventor, about 80 millimeters, locality 10; *2*, Lateral view of a broken paratype, diameter about 95 millimeters, locality 5; *3*, A portion of inner volution of the holotype, (figure 11, plate 3), showing constriction line, suture line, longitudinal ribs, and faint transverse markings at the umbilical wall, locality 5; *4*, Lateral view of a paratype, about 85 to 90 millimeters in diameter, locality 5; *5*, Ventral-lateral view of a paratype about 45 millimeters in diameter, showing longitudinal ribs, constrictions, sutures, and faint transverse markings at umbilical wall, locality 5; *6*, Ventral view of a paratype about 60 millimeters in diameter, showing suture lines, and the faint longitudinal lirae, a specimen from locality 10. (p. 697)

cies. The ventral and lateral portions of the conch are distinctly marked by 50 to 60 longitudinal lirae or sharply defined, narrowly rounded ridges whose reciprocals are shallow but broader-rounded intervening grooves. These longitudinal markings persist into very late maturity at least. The size of the lirae increases progressively with the growth of the conch. Their spacing in ventral and lateral zones is approximately uniform, but they may not be present on the lateral walls of the umbilicus.

The lateral walls of the umbilical area are marked by faint transverse ribs that appear to be indistinctly nodose or slightly tuberculate; the transverse ribs are radiate in form, inclined slightly forward, and extend even to the umbilical wall of the outer whorl. These transverse ribs are never well developed and apparently become obsolete at maturity.

The internal mold of the conch is conspicuously marked by sinuous transverse constrictions. In the ventral area the constrictions form a shallow, broadly rounded U-shaped sinus. On each side of the ventral sinus there is a broadly rounded ventral-lateral salient that becomes an approximate straight line in its extension dorsally to the umbilical walls.

The mature suture of the conch consists of a conspicuous, divided symmetrical ventral lobe and on either side of it a large prominent, nearly symmetrical U-shaped first lateral saddle; a deep narrow symmetrical V-shaped first lateral lobe; a broad asymmetrical second lateral saddle; and a V-shaped subangular lobe on the umbilical wall.

Remarks.—*Pseudogastrioceras texanum*, n. sp. from the Blaine and the Dog Creek formations may be discriminated from other congeneric forms, particularly *P. altudense*, *P. roadense*, and *P. serratum*, by the number of its longitudinal lirae, by its conspicuous constrictions, and by the shape and form of its suture line.

Occurrence.—Acme member of the Blaine at locality 5; Guthrie member of the Dog Creek at locality 10. Common but not abundant.

Holotype and paratypes.—State University of Iowa.

Genus ADRIANITES Gemmellaro
ADRIANITES NEWELLI Miller and Furnish
Plate 102, figure 18

Adrianites newelli MILLER and FURNISH, *1940*, Geol. Soc. America, Spec. Paper 26, p. 117, pl. 25, figs. 1–3.

Occurrence.—Guthrie member of the Dog Creek at locality 10, where its occurrence is scarce.

Hypotype.—State University of Iowa.

Genus AGATHICERAS Gemmellaro
AGATHICERAS GIRTYI Böse

Agathiceras girtyi BÖSE, *1917*, Texas Univ. Bull. 1762, p. 117–121, pl. 6, figs. 27–46.
Agathiceras girtyi BAKER (fide J. P. Smith), *1929*, Texas Univ. Bull. 2901, p. 79, pl. 29, figs. 7–10.
Agathiceras girtyi PLUMMER and SCOTT, *1937*, Texas Univ. Bull., p. 123, pl. 29, figs. 7–10.
Agathiceras girtyi MILLER and FURNISH, *1940*, Geol. Soc. America, Spec. Paper 26, p. 119, pl. 31, figs. 1–7.

Occurrence.—Acme member of the Blaine, locality 5, where occurrence is scarce; Guthrie member of the Dog Creek, locality 10, where occurrence is common.

Genus PERRINITES Böse
PERRINITES HILLI (Smith)
Plate 103, figures 9, 10

Waagenoceras hilli SMITH, *1903*, U. S. Geol. Survey, Mon. 42, p. 140, pl. 27, figs. 1–3.
Perrinites hilli BÖSE, *1917*, Texas Univ. Bull. 1762, p. 26, 160, and 190.
Perrinites hilli PLUMMER and SCOTT, *1937*, Texas Univ. Bull. 3701, p. 319, pl. 27, figs. 1–4.
Perrinites hilli MILLER and FURNISH, *1940*, Geol. Soc. America, Spec. Paper 26, p. 147–150, pl. 34, fig. 5.
Perrinites gouldi PLUMMER and SCOTT, *1937*, Texas Univ. Bull, 3701, p. 317, pl. 26, figs. 1–5.
Perrinites hilli hilli MILLER and FURNISH, *1940*, Geol. Soc. America, Spec. Paper 26, p. 147, 148, 149, 150, 152–153, pl. 33, figs. 1, 2; pl. 34, figs. 1, 2, 7; pl. 35, fig. 1; pl. 36, fig. 2; pl. 37, figs. 1, 2.
Perrinites hilli gouldi MILLER and FURNISH, *1940*, Geol. Soc. America, Spec. Paper 26, p. 148, 149, 152, pl. 35, fig. 2; pl. 36, fig. 1.

The holotype for *Perrinites hilli* (Smith) came from the Guthrie member of the Dog Creek, at a locality known as the Croton Falls area, in Stonewall County, Texas. Although two species and as many varieties for *Perrinites* have been discriminated from the Blaine and the Dog Creek formations, all such forms are here assigned only to *Perrinites hilli* (Smith). That these forms are conspecific is a view previously ex-

pressed by Miller and Furnish after comparing *Perrinites* specimens from strata of the Guthrie member of the Dog Creek at a locality about six miles north of Aspermont, Texas, with *Perrinites* that occur in strata of the Acme member of the Blaine, near Quanah, Texas.

Occurrence.—Acme member of the Blaine at localities 1, 2, 3, 5, 6, and 7; Guthrie member of the Dog Creek at localities 9, 10, 10A, 11, and 12. Very common to abundant at localities 5 and 10; common at localities 6, 9, and 10A; scarce to rare at the other localities.

Hypotypes.—State University of Iowa.

REFERENCES

BEEDE, J. W., *1902*, Invertebrate paleontology of the red beds, *Oklahoma Geol. Survey, 1st Bienn. Rept., Advance Bull.*, p. 1–11, pl. 1.

——, *1906*, Invertebrate paleontology of the upper Permian red beds of Oklahoma and the Panhandle of Texas, *Kansas Univ. Sci. Bull.*, vol. 4, p. 113–171, pls. 1–8.

BÖSE, EMIL, *1917*, Permo-Carboniferous ammonoids of the Glass Mountains, *Texas Univ. Bull.* 1762, p. 1–241, pls. 1–11.

CRAGIN, F. W., *1896*, Permian system of Kansas, *Colorado College Studies*, vol. 6, p. 3–33.

DEFORD, R. K., and LLOYD, E. RUSSELL, *1940*, West Texas-New Mexico Symposium pt. 1, *Am. Assoc. Petroleum Geologists Bull.*, vol. 24, p. 1–14, figs. 1, 2.

GIRTY, C. H., *1908*, The Guadalupian fauna, *U. S. Geol. Survey, Prof. Paper* 58, p. 1–651, pls. 1–31.

——, *1909*, The Manzano Group, *U. S. Geol. Survey, Bull.* 389, p. 1–141, pls. 1–12.

GOULD, C. N., *1902*, General Geology of Oklahoma, *Oklahoma Geol. Survey, 2nd. Bienn. Rept.*, p. 40–57.

KING, ROBERT E., *1930*, Geology of the Glass Mountains, Texas. Part II, *Texas Univ. Bull.* 3042, p. 1–245, pls. 1–50.

LLOYD, A. M., and THOMPSON, W. C., *1929*, Correlation of Permian outcrops on eastern side of West Texas Basin, *Am. Assoc. Petroleum Geologists Bull.*, vol. 13, p. 945–956, pl. 9.

MCKEE, E. D., *1938*, Toroweap and Kaibab formations of Arizona and Utah, *Carnegie Institution Wash.*, Pub. 492, pt. 1, p. 153–221; pt. 2, p. 222–268, pls. 8, 12, 15–21, and 39–48.

MILLER, A. K., DUNBAR, C. O., and CONDRA, G. E., *1933*, The nautiloid cephalopods of the Pennsylvanian system in the Mid-Continent region, *Nebraska Geol. Survey*, vol. 9, 2nd. ser. p. 1–240, pls. 1–24.

MILLER, A. K., and FURNISH, W. M., *1940*, The Permian ammonoids of the Guadalupe Mountain region and adjacent areas. *Geol. Soc. Am., Spec. Paper* 26, p. 1–242, pls. 2–44.

NEWELL, NORMAN D., *1937*, Late Paleozoic Pelecypods; Pectinacea, *Kansas Geol. Survey*, vol. 10, p. 1–123, pls. 1–19, text and atlas.

——, *1940*, Invertebrate fauna of the late Permian Whitehorse sandstone, *Geol. Soc. Am. Bull.* 51, p. 261–336, pls. 1–10.

PLUMMER, F. B., and SCOTT, GAYLE, *1937*, Upper Paleozoic ammonoids in Texas, the Geology of Texas, vol. 3, *Texas Univ. Bull.* 3701, p. 1–516, pls. 1–41.

SMITH, J. P., *1903*, The carboniferous ammonoids of America, *U. S. Geol. Survey*, Mon. 42, p. 1–211, pls. 1–29.

WHITE, C. A., *1877*, Paleontology, *U. S. Geol. Survey, W. 100th Mer. Rept.*, vol. 4, p. 96–160, pls. 6–12.

WRATHER, W. E., *1917*, Notes on the Texas Permian, *SW. Assoc. Petrol. Geol. Bull.*, vol. 1, p. 93–106.

JOURNAL OF PALEONTOLOGY, VOL. 16, NO. 6, PP. 700–711, PLS. 105–109, 2 TEXT FIGS., NOVEMBER, 1942

PERMIAN FUSULINIDS FROM BRITISH COLUMBIA, WASHINGTON AND OREGON

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ABSTRACT—*Staffella* (?) sp., *Nankinella* (?) sp., *Schwagerina pavilionensis*, n. sp., *S. pavilionensis* var. *acris*, n. var., *Yabeina minuta*, n. sp., and *Y. columbiana* (Dawson) are described from the Marble Canyon limestone of the Cache Creek series of southern British Columbia; and *Yabeina packardi*, n. sp., is described from the Permian of central Oregon. Also, a closely similar fusulinid fauna containing *Yabeina* is reported from Washington. This is the first time the genus *Yabeina* has been recognized in the Permian of America.

The Marble Canyon limestone of British Columbia, and the limestones of central Oregon and Washington which contain *Yabeina*, probably represent the youngest marine Permian known from America.

THE METAMORPHOSED clastics, limestones and volcanics outcropping between Cache Creek, on the Bonaparte River, and Marble Canyon, near Lillooet, southern British Columbia, were described in 1872 by Selwyn as the Cache Creek group. Since 1872 most workers have referred to these sediments and interbedded volcanics in southern British Columbia as the Cache Creek series. In 1896 Dawson proposed the term "Marble Cañon limestone" for the thick metamorphosed limestones of the upper Cache Creek which form the walls of Marble Canyon.

The complicated structure and metamorphic alteration of the Cache Creek rocks make it almost impossible to determine with any degree of accuracy their thickness or exact stratigraphic sequence. In 1915 Daly (pp. 120, 121) worked out a "provisional statement of the succession" of the Cache Creek near Kamloops, on South Thompson River, about 50 miles east by southeast of Cache Creek, and he gave a thickness of 13,700 feet for the rocks which he referred to the series. Daly pointed out that "near the contact with the [overlying] Triassic the disorder is so great that no simple description of the structure is possible." The upper 1000 feet of the Cache Creek series as measured by Daly on South Thompson River are massive, fossiliferous, and cherty limestones. Most Cache Creek faunas so far studied have been obtained from this thick limestone portion of the series.

The Cache Creek series is well exposed in numerous localities in southern British Columbia, including the regions around Cache Creek; near Lillooet, in Marble Canyon between Fraser River and Hat Creek; and along South Thompson River between Kamloops and Campbell Siding. Also, in 1889 Dawson (p. 170B) described from the extreme northwest portion of British Columbia near Bennet Lake, north of Juneau, Alaska, a sequence which "closely resembles, both lithologically and in its fossils, the typical area of the Cache Creek series on the Thompson and Fraser." At the same time Dawson (1889, p. 33B) reports "several thousand feet" of limestone, with "fossils of Carboniferous age, including —*Fusulina*," in northern British Columbia along the Dease and Frances rivers and on Tagish Lake. This limestone occurs with quartzites similar to those associated with the limestones of the typical Cache Creek series on the Fraser and Thompson rivers. So far as we have been able to determine, these faunas reported from northern British Columbia have not been studied in detail and therefore the age of no part of this thick series of rocks is definitely known.

Smith and Calkins (1904) have identified a thick series of highly metamorphosed limestones, slates, schists, quartzites, and greenstone from northern Washington as belonging to the Cache Creek series. This correlation was suggested mainly because of similarity in lithology between the Washing-

ton strata and the typical Cache Creek.

These few references represent only a small percentage of the numerous reports of rocks in various regions of British Columbia and adjacent territory which lithologically resemble the typical Cache Creek. However, it is obvious from the references herein given that rocks which resemble the Cache Creek, at least in general lithology, are widespread from Washington on the south to the northern region of British Columbia.

In 1915 Daly reported collecting fossils from several horizons in the Cache Creek near Kamloops, the largest collection of which came from the upper 1000 feet of the series. Girty (in Daly, 1915, p. 122), who studied this fauna, reported that it "may be Gschelian" (Upper Pennsylvanian) in age but that several poorly preserved fragments from over 4000 feet below the top of the Cache Creek "suggest the Artinskian."

In 1933 Miller and Warren described *Propinacoceras americanum* from the upper 1000 feet of the Cache Creek series as described and measured by Daly near Kamloops on South Thompson River. Although this was the only representative of the ammonoid genus *Propinacoceras* known from America, very closely similar forms were known from the Sosio beds of Sicily, which in turn are associated with ammonoids closely similar to the ammonoid fauna of the Word of Texas. It was therefore suggested by Miller and Warren that the horizon of their collection from the upper unit of the Cache Creek near Kamloops should be correlated with the Word of Texas. In 1936 Miller and Crockford described some additional cephalopods from the same portion of the Cache Creek, and their study did not alter the earlier conclusions of Miller and Warren.

In 1940 Miller and Furnish (pp. 40–44) described the second American representative of the ammonoid genus *Propinacoceras*, *P. knighti*, from the Leonard formation and the Bone Spring limestone of western Texas. However, these workers point out that the genus *Propinacoceras* has a known stratigraphic range from the Leonard of Texas to the upper Permian *Timorites* zone of the Las Delicias beds of Coahuila, Mexico, and that questionable representatives of this genus are also known from the Upper Permian Amarassi beds of Timor and from the Upper Permian Ambilobé beds of Madagascar.

In 1935 Crockford and Warren described a portion of the fauna of the Cache Creek from near Kamloops. They pointed out the marked similarity of the Cache Creek fauna with the "Tethys Sea" faunas of Europe and Asia, and they stressed the lack of similarity between the Cache Creek fauna and the Permian faunas of other areas in America. They identified only one species as a previously described American form, and that was *Spiriferina billingsi* Shumard, first described from the Capitan limestone of Texas.

In 1879 Dawson described a foraminifer from cobbles found in Marble Canyon, southern British Columbia, as *Loftusia columbiana*, and in 1912 Staff inferred that he believed this form belonged to the subfamily Neoschwagerininae. In 1932 Dunbar obtained Dawson's original sections of *L. columbiana* and redescribed and illustrated this species as *Neoschwagerina columbiana*. Although none of Dawson's sections seems to be well oriented or centered, they do show clearly that this form represents a fusulinid of the subfamily Neoschwagerininae.

In 1898 Turner listed a foraminifer from the Calaveras formation at the Diadem Mine in Plumas County, northern California, as *Loftusia columbiana*. Staff (1912, p. 186) stated in 1912 that if Turner's material is not oölite,[1] it is probably a neoschwagerinid, and at the same time Staff (1912, p. 161) listed "*Neoschwagerina* sp. ind." from California without giving the locality or horizon of his collection.

So far as we have been able to determine, these are the only references in the literature to fusulinids of the subfamily Neoschwagerininae from America, except that Dunbar (1941) mentions "the occurrence of neoschwagerines in a narrow belt extending from Kamloops, British Columbia, into Washington and Oregon."

The associate author of this paper spent several days during the summer of 1933 in Marble Canyon near Lillooet, British

[1] We have examined samples of white limestone collected near the Diadem Mine in Plumas County, California, apparently the same locality as Turner's sample. This rock contains numerous pellets of about the same size and general shape of a neoschwagerinid fusulinid. However, all of our material seems to be oölite.

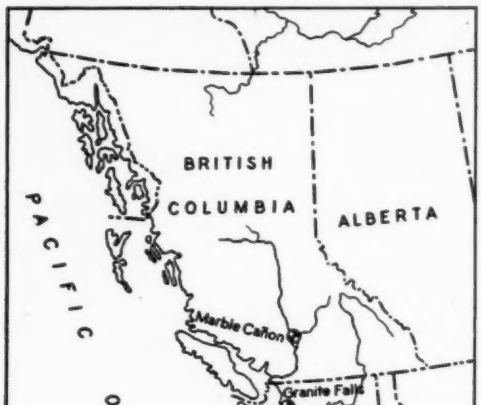


FIG. 1—Map of northwestern North America showing the localities of Permian *Yabeina* zone fusulinids.

Columbia, the type locality of Dawson's species, and obtained from the north shore of the middle of the three Pavilion Lakes numerous cobbles of Marble Canyon limestone (Dawson, 1896) which contain an abundance of fusulinids (text-fig. 1 and text-fig. 2, loc. 3). The time available would permit neither the finding of these fossils in place, nor the determination of the stratigraphic relationships of the Marble Canyon limestone to the remainder of the Cache Creek series of this region. These limestones weather light grey to white but on fresh surfaces they are dark grey to black. Numerous shear zones and much distortion of the fossils, as well as schistose structures, indicate high pressures of deformation. It is difficult to trace any one stratum along the canyon faces or down the canyon walls. However, the Marble Canyon limestone is undoubtedly more than 1000 feet thick. From Daly's description of the sequence at Kamloops, 65 miles easterly, from statements of Crockford and Warren, and on the basis of comparison with other Cache Creek sections described in southern British Columbia, there can be little doubt that the Marble Canyon limestone corresponds in age, at least in part, to the upper unit of the thick sedimentary and volcanic sequence found on the South Thompson River.

From a study of well oriented sections of *Loftusia columbiana* Dawson (Pl. 106, fig. 5; Pl. 107, fig. 5; Pl. 108, fig. 1; Pl. 109, figs. 1–4) it becomes obvious that this form should be referred to the genus *Yabeina* Deprat. In addition to *Y. columbiana*, we have obtained from these Marble Canyon samples, representatives of one new species of *Yabeina*, *Y. minuta* (Pl. 106, figs. 6–10) one new species and one new variety of the genus *Schwagerina* Möller, *S. pavilionensis* (Pl. 105, figs. 3–6) and *S. pavilionensis* var. *acris* (Pl. 105, figs. 1, 2), poorly preserved specimens which we are referring with question to the genus *Nankinella* Lee (Pl. 106, figs. 1–3), and poorly preserved specimens which we are referring with question to the genus *Staffella* Ozawa.

Dr. E. L. Packard of Oregon State College sent us a cobble of dark grey limestone from central Oregon (text-fig. 1 and text-fig. 2, loc. 1) that contains well preserved specimens of an undescribed species of *Yabeina*, *Y. packardi*, n. sp. (Pl. 106, fig. 4; Pl. 107, figs. 2–4; Pl. 108, fig. 4). Through the courtesy of Dr. Lloyd W. Staples of the University of Oregon, we have learned that this cobble of limestone was presented to Mr. Lewis Erving of Madras, Oregon, in 1935, by an unknown collector, who stated that it came from the base of Gray Butte, Jefferson County (almost on the Deschutes County line), Oregon. The cobble is waterworn, and probably was collected from Tertiary gravels. That the original source of the cobble was not far distant is suggested by its composition and large size (over 150 mm. in diameter), since limestone normally withstands but little transportation. Although *Yabeina packardi* is more highly developed biologically than any of the species of *Yabeina* found in the British Columbian collections, there seems little doubt that the Permian stratum from which this cobble was derived is closely related in age to the Marble Canyon limestone of the Cache Creek series of British Columbia.

Through the courtesy of Dr. R. L. Lupher and Mr. Roy A. Anderson of Washington

State College, we have been able to study thin sections of a fusulinid-bearing limestone in northwestern Washington. The material was collected by Dr. Harold E. Culver and Anderson in 1935, from a limestone quarry on the south side of Canyon Creek, a tributary of the south fork of the Stilaguamish River, about three miles northeast of Granite Falls, Snohomish County, Washington (text-fig. 1 and text-fig. 2, loc. 2). The stratigraphic relationships of this crystalline and massive limestone are unknown other than that it "lies in contact with and on a dark basic igneous rock and shows very little sign of stratification" (Shedd, 1913). This limestone contains an undescribed species of the genus *Schwagerina*, a representative of the genus *Yabeina*, and a representative of the genus *Schubertella*. The species of *Yabeina* found near Granite Falls, Washington, seems to be closely related to *Y. packardi* from near Madras, Oregon, but we have not seen sufficiently well oriented sections of the Washington species for specific comparisons. However, the Washington fusulinid-bearing beds are undoubtedly closely related in age to the Permian beds from which the Oregon cobble was derived.[1a]

The fusulinid genus *Yabeina* was established by Deprat in 1914 with *Y. inouyei* Deprat from the Permian of Akasaka, Japan, as the genotype (see Pl. 107, fig. 5). This genus belongs to the subfamily Neoschwagerininae Staff, members of which are distinguished from those of other subfamilies of the family Fusulinidae by the presence of transverse septula, and in most members the presence of transverse and axial septula. We are recognizing the following genera as members of the subfamily Neoschwagerininae: *Cancellina* Hayden, *Neoschwagerina* Yabe, *Yabeina* Deprat, and *Sumatrina* Volz. Lee (1933) has proposed the name *Colania* for intermediate forms between *Neoschwagerina* and *Yabeina* and the name *Lepidolina* for highly developed representatives of *Yabeina*.

Representatives of *Yabeina* can be distinguished from representatives of *Neoschwagerina* by the presence of secondary transverse septula between the primary transverse septula in the outer volutions of mature specimens and by the larger number of axial septula between the septa in mature specimens of *Yabeina*. In the original figures of the genotype of *Neoschwagerina*, *Schwagerina craticulifera* Schwager (see Pl. 108, figs. 2, 3), a maximum of two axial septula were shown between adjacent septa; whereas, in *Yabeina* as many as seven to nine axial septula have been observed between adjacent septa in some species. Also, the keriothecal structure of the spirotheca extends almost to the base of the septula in *Neoschwagerina*, but it is not recognizable in the lower portion of septula of representatives of *Yabeina*. In representatives of *Sumatrina* the axial septula and the secondary transverse septula are very numerous, they are pendantlike and uniform in length. In representatives of *Yabeina* the septula are numerous, they vary considerably in shape even in the same specimen, and they are not uniform in length. In representatives of *Yabeina* the spirotheca is thick and contains alveoli; whereas, in representatives of *Sumatrina* the spirotheca is very thin and appears to be composed of only one layer.

Although representatives of *Yabeina* are widespread geographically in the Eastern Hemisphere, the genus has not been recognized previously from America, and the only representative to have been described previously from America is *Loftusia columbiana* Dawson from Marble Canyon, redescribed below. Two species of *Yabeina* were described and illustrated by Douvillé (1934) from the Permian Djebel Tebaga beds of extreme southern Tunisia (text fig. 2, loc. 10) as *Neoschwagerina syrthalis* Douvillé and "*Neoschwagerina globosa* Yabe, race *subaequalis*." The first of these species occurs

[1a] Since this manuscript was submitted, we have received a copy of an important paper by R. A. Anderson (Research Studies State College of Washington, vol. 9, pp. 189–202, pls. 1, 2, 1941) in which the fusulinids from the Granite Falls limestone of Washington was described and illustrated. One of these fusulinids were described as *Neoschwagerina cascadensis* Anderson. Dr. R. L. Lupher kindly sent us a large quantity of the Granite Falls limestone and we have obtained numerous well oriented sections of the fusulinids. Our sections demonstrate that *N. cascadensis* Anderson is referable to the genus *Yabeina* Deprat and that it is biologically more primitive than *Y. packardi* Thompson and Wheeler, n. sp., from central Oregon, described below.

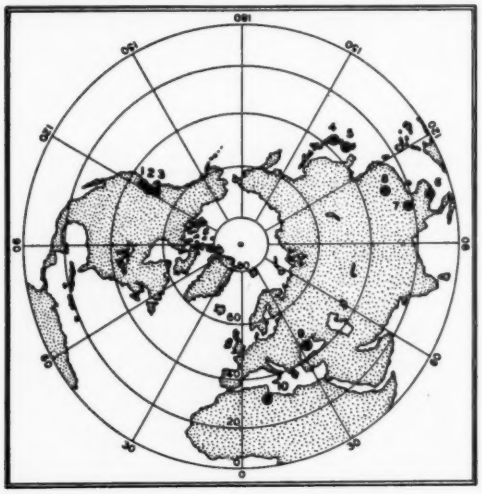


FIG. 2—Map of the Northern Hemisphere showing the distribution of the genus *Yabeina* Deprat.

in the upper 570 meters of the fusulinid-bearing portion of the Permian of this area, without any associated fusulinids reported, and the second is found associated with *Neoschwagerina* 60 to 240 meters lower in the section. However, these two species of *Yabeina* were not reported in association with each other.

Dr. O. Toumansky has sent us a photograph of a representative of *Yabeina* from Crimea (text fig. 2, loc. 9), neither the horizon nor the associated fusulinids of which is known to us.

In 1924 Lee and Choa reported *Y. inouyei* from the gorge of the Yangtze River in southern China (text fig. 2, loc. 8) in the middle unit of the Wushan limestone where it is apparently associated with *Neoschwagerina*. *Yabeina multiseptata* was reported by Deprat (1914, pp. 34, 35, 42) from the uppermost Permian of Cambodge, French Indo-China (text fig. 2, loc. 6), and from the uppermost Permian of Yun-Nan, China (text fig. 2, loc. 7).

Representatives of *Yabeina*, including the genotype, have been described by Deprat (1914) and Ozawa (1927) from the upper portion of the Permian beds found near Akasaka, Japan (text fig. 2, loc. 5). Ozawa found that *Yabeina* is confined to the upper two "Successions," 12 and 11, of the famous section near Akasaka, Province of Mino, Japan, and that the zone of *Verbeekina*, *Neoschwagerina* and *Sumatrina* is stratigraphically lower. There seems to be no evidence that any of our middle or upper Permian American fusulinid genera, such as *Parafusulina* and *Polydiexodina*, is associated with *Yabeina* in this area. Apparently *Sumatrina?* and *Neoschwagerina* are the only genera found with *Yabeina* in the upper two "Successions" at Akasaka.[2]

Huzimoto (1936) described several representatives of *Yabeina* from the upper portion of the Titibu "system" in the Kwanto Mountain area of Japan (text-fig. 2, loc. 4), where they are associated with representatives of *Neoschwagerina*, *Misellina* and *Schwagerina* [*Parafusulina?*].

In all the areas mentioned above, our information indicates that where the stratigraphic section has been worked out in detail, the genus *Yabeina* is recognized only in the uppermost portions of the fusulinid-bearing Permian sediments of the "Tethys Sea" areas of the Eastern Hemisphere, and that *Yabeina* occurs stratigraphically higher than the "Middle Permian" fusulinid zone of *Verbeekina*, *Neoschwagerina* and *Sumatrina*.

The genus *Schwagerina* has a much longer stratigraphic range in the Orient than it has been given previously in America. Representatives of *Schwagerina* have been de-

[2] Yabe (1940) mentions *Yabeina*, *Neoschwagerina*, *Sumatrina* and *Parafusulina* as being associated in a limestone "Lens" in graywacke south of the main fault bordering the complicated region of the Akiyosi Plateau, but just how close this association may be is not known to us.

EXPLANATION OF PLATE 105

All illustrations on this plate are unretouched photographs and all are magnified ×10.

FIGS. *1*, *2*—*Schwagerina pavilionensis* var. *acris* Thompson and Wheeler, n. var. *1*, Axial section; *2*, sagittal section. Marble Canyon limestone. (p. 707)

3–6—*Schwagerina pavilionensis* Thompson and Wheeler, n. sp. *3*, Sagittal section; *4*, *5*, axial sections; *6*, tangential section which shows the nature of the septal fluting. Marble Canyon limestone. (p. 706)

Thompson and Wheeler, Permian Fusulinids

Thompson and Wheeler, Permian Fusulinids

scribed from the *Pseudoschwagerina* zone, the *Parafusulina* zone and the overlying zone of *Verbeekina*, *Neoschwagerina* and *Sumatrina* of many areas in the Eastern Hemisphere, and also from the upper fusulinid zone of the Permian of the Orient, the *Yabeina* zone. In the central portion of North America *Schwagerina* seems to be restricted to the *Pseudoschwagerina* zone (Wolfcamp) and the lower portion of the *Parafusulina* zone (Leonard). As the genus is defined by most workers at the present time, *Schwagerina* merely indicates a Permian age for the containing beds.

The limits of the stratigraphic ranges of the genera *Nankinella* Lee and *Staffella* Ozawa are not well known. Therefore, the presence of questionable representatives of these two genera in the Marble Canyon limestone gives little additional stratigraphic information.

Studies by Thompson (1941) of fusulinids collected by H. G. Schenck, H. M. Kirk, and C. L. Postle near Bamian, Afghanistan, the same locality as that from which Hayden (1909), obtained his fusulinid collections demonstrates the association of representatives of the genus *Polydiexodina* Dunbar and Skinner with representatives of the genera *Sumatrina* Volz?, *Neoschwagerina* Yabe, *Cancellina* Hayden, *Verbeekina* Staff, *Schwagerina* Möller and *Schubertella* Staff and Wedekind. These studies strongly suggest the correlative ages of the *Polydiexodina* zone of America and the zone of *Verbeekina*, *Neoschwagerina* and *Sumatrina* of Eurasia. Representatives of the genus *Polydiexodina* are considered among the most reliable index fossils of the upper portion of the Guadalupe series of America, and the genus apparently is restricted to the upper portion of the Guadalupian. Although the species of *Polydiexodina* from Afghanistan is not a highly developed form of the genus, its presence in the deposits near Bamian seems to us to demonstrate a Guadalupian age for a portion of the zone of *Verbeekina*, *Neoschwagerina* and *Sumatrina* of the "Tethys Sea" areas of Eurasia. Since the *Yabeina* zone of the Eastern Hemisphere is younger stratigraphically than the zone of *Verbeekina*, *Neoschwagerina* and *Sumatrina* in all areas where the stratigraphic section has been worked out in detail, we consider the Marble Canyon limestone from which our British Columbian collections were derived, as well as the closely related sediments of Washington and Oregon which contain *Yabeina*, younger than most if not all of the Guadalupe series of other areas in America. It seems to us that the sea of late Cache Creek time was the last known Paleozoic marine invasion of North America.

SYSTEMATIC DESCRIPTIONS

Family FUSULINIDAE Möller
Subfamily OZAWAINELLINAE Thompson and Foster
Genus NANKINELLA Lee

NANKINELLA (?) sp.
Plate 106, figures 1–3

Although the specimens before us which we are referring with question to *Nankinella* Lee beyond a doubt are referable to the fusulinid subfamily Ozawainellinae Thompson and Foster, their generic affinities are uncertain. Our specimens are poorly preserved and we do not feel sure that any of them is fully mature. In view of these uncertainties, we are referring our specimens with question to the genus *Nankinella* Lee, although we realize that they may be referable to the genus *Ozawainella* Thompson. For the sake of completeness we are illustrating three of our better specimens.

All of our specimens are discoidal in shape

EXPLANATION OF PLATE 106

All illustrations on this plate are unretouched photographs and all are magnified ×10.

FIGS. *1–3*—*Nankinella* (?) sp. *1*, *3*, Tangential sections; *2*, axial section. Marble Canyon limestone (p. 705)

4—*Yabeina packardi* Thompson and Wheeler, n. sp. Slightly oblique tangential section. Permian limestone of central Oregon. (p. 710)

5—*Yabeina columbiana* (Dawson). Axial section of a submature specimen. Marble Canyon limestone (p. 708)

6–9, (?) *10*—*Yabeina minuta* Thompson and Wheeler, n. sp. *6*, *7*, *9*, Axial sections; *8*, sagittal section; *10*, sagittal section of a specimen which we are referring with question to this species. Marble Canyon limestone. (p. 707)

with a sharply angular periphery and form ratios of 1:0.46 to 1:0.75. Our largest specimens measure 0.7 to 1.4 mm. in width and 0.5 to 0.9 mm. in length. The proloculum is minute and its inside diameter measures about 50 microns. Our largest specimen contains at least five volutions. A tunnel is present and it is bounded by poorly developed chomata.

Occurrence.—The specimens which we are referring with question to the genus *Nankinella* are from the Marble Canyon limestone, Marble Canyon, southern British Columbia, where they are associated with *Yabeina columbiana* (Dawson) and *Staffella* (?) sp.

Figured specimens.—Stanford Univ. Paleo. Type Coll. No. 7328.

Genus STAFFELLA Ozawa

STAFFELLA (?) sp.

Several small spherical specimens of fusulinids occur among our collections obtained from the Marble Canyon limestone near Lillooet, southern British Columbia, which seem to have a discoidal early stage and which are spherical in shape in the outer volutions. Our specimens are poorly preserved and may not be of mature individuals, and until better preserved material is obtained we prefer to refer our specimens with question to the genus *Staffella*.

Our largest specimens measure about 1.0 mm. in diameter and have a form ratio of about 1:1. The proloculum and the innermost volutions have not been observed. Chomata are poorly developed. The septa are unfluted. The detailed structure of the spirotheca can not be determined.

Occurrence.—The specimens mentioned above are associated with *Yabeina columbiana* (Dawson) and *Nankinella* (?) sp. in the Marble Canyon limestone, Marble Canyon, southern British Columbia.

Subfamily SCHWAGERININAE Dunbar and Henbest

Genus SCHWAGERINA Möller

SCHWAGERINA PAVILIONENSIS Thompson and Wheeler, n. sp.

Plate 105, figures 3–6

Shell large, inflated fusiform; with sharply pointed poles, essentially uniform lateral slopes, and straight axis of coiling. Mature specimens of nine to nine and one-half volutions measure 4.0 to 4.5 mm. in width and 9.4 to 11.3 mm. in length, giving a form ratio of 1:2.2 to 1:2.6. The average form ratio of four typical specimens is 1:2.4. The form ratio of the fifth volution is 1:2.5 to 1:2.7 and that of the seventh volution is 1:2.3 to 1:2.5. As is obvious from these figures, the shell becomes more highly inflated with growth.

The proloculum is large, and its diameter measures 210 to 325 microns, with an average inside diameter of 270 microns for six specimens. The inner three to four volutions are tightly coiled, but beyond the fourth volution the shell expands uniformly. The averages of the heights of the first to the ninth volution of three specimens are 73, 91, 130, 166, 208, 255, 291, 322, and 320 microns, respectively.

The spirotheca is thick and is composed of a tectum and a keriotheca with coarse alveoli. The spirotheca increases in thickness slowly during the inner five volutions. From the fifth to the seventh volution the spirotheca increases in thickness rapidly, but beyond the seventh volution the thickness of the spirotheca increases only slightly. The averages of the thickness of the spirotheca in the first to the ninth volution of three typical specimens are 32, 38, 48, 55, 64, 81, 87, 93, and 96 microns, respectively.

The tunnel is low and narrow in the inner five volutions. Beyond the fifth volution the tunnel increases in width rapidly. The tunnel angle measures about 23 degrees in the third and fifth volution, 26 degrees in the seventh volution, and 32 degrees in the ninth volution. Low and narrow chomata border the tunnel in the inner five to six volutions but in the outer volutions the deposits of calcite bordering the tunnel are light and irregular to discontinuous. Heavy deposits of dense calcite completely fill the chambers in the axial regions of all volutions except those of the outer one or two volutions. The axial fillings extend about one-third the distance from the poles to the tunnel.

The septa are very thin and the septal count of the first to the ninth volution of a typical specimen is 11, 17, 20, 21, 21, 27, 28, 29, and 31. The septa are narrowly and highly fluted throughout the shell. The fluting forms chamberlets which reach over

three-fourths the height of the chambers.[3]

Discussion.—*S. pavilionensis* does not closely resemble any previously described American species. However, it does somewhat closely resemble specimens from Japan which have been illustrated as *Schwagerina* [*Parafusulina*?] *japonica* (Gümble). *S. pavilionensis* differs from *S. japonica* Ozawa in several respects, especially in that its axial fillings are much heavier and its shell is more tightly coiled (compare with Plate 36, Ozawa, 1927).

Occurrence.—This species is known only from the Marble Canyon limestone, Marble Canyon, near Lillooet, British Columbia.

Types. Figured syntypes Stanford Univ. Paleo. Type Coll. No. 7329.

SCHWAGERINA PAVILIONENSIS var. ACRIS Thompson and Wheeler, n. var.
Plate 105, figures 1, 2

Shell large, elongate fusiform; with sharply pointed poles, low lateral slopes, and straight to broadly curving axis. Mature specimens consist of eight to ten volutions and measure about 13.8 mm. in length and 3.7 mm. in width, giving a form ratio of about 1:3.8.

The proloculum is large and its inside diameter measures 265 microns in two typical specimens. The expansion of the shell is essentially uniform and the heights of the first to the ninth volution of the figured axial section are 62, 78, 109, 125, 125, 187, 234, 250, and 250 microns, respectively.

The spirotheca is thick and is composed of a tectum and a thick keriotheca with coarse alveoli. The thickness of the spirotheca in the second to the tenth volution of the figured axial section measures 29, 29, 36, 50, 61, 64, 86, 89, and 89 microns, respectively.

The tunnel is low and narrow in the innermost volutions and it gradually increases in width in the outer volutions. The tunnel angle measures about 24 degrees in the third volution, 28 degrees in the fifth volution, 30 degrees in the seventh volution, and 40 degrees in the eight volution. The chomata form low and indistinct ridges in the inner volutions and in the outer volutions the chomata deposits are discontinuous and irregular. Heavy deposits of dense calcite completely fill the chambers of all volutions except those in the outermost volution. The axial fillings extend one-fifth to one-third the distance from the poles to the tunnel.

The septa are thin and numerous. The septal count of the first to the eighth volution of the figured sagittal section is 12, 21, 21, 27, 30, 35, 35, and 39, respectively. The septa are highly and narrowly fluted throughout the length of the shell and the fluting reaches the top of the chambers. There are about 25 complete folds in the eighth volution. The chamberlets formed by the fluting reach slightly over one-half the height of the chambers.

Discussion.—The variety *acris* differs from the typical variety *pavilionensis* in that it is more highly elongate and less highly inflated, has a thinner spirotheca for corresponding volutions, larger tunnel angle for corresponding volutions, more uniformly expanding shell, and lighter axial fillings. However, this variety is based on a small number of specimens and the differences pointed out above may be more apparent than real.

Occurrence.—Marble Canyon limestone of the Cache Creek series, Marble Canyon, southern British Columbia.

Types.—Figured syntypes Stanford Univ. Paleo. Type Coll. No. 7330.

Subfamily NEOSCHWAGERININAE Staff

Genus YABEINA Deprat

YABEINA MINUTA Thompson and Wheeler, n. sp.
Plate 106, figures 6–9, (?) 10

Shell small, inflated fusiform; with straight axis of coiling and steep lateral slopes. Mature specimens consist of thirteen to fifteen volutions and measure 5.0 to 7.5 mm. in length and 2.5 to 3.6 mm. in width. The form ratio of mature specimens is 1:1.7 to

[3] In the outer volutions of some specimens, tangential sections show some slight evidence of cuniculi (see Pl. 105, fig. 6). In all specimens where this has been observed at all, however, the shell has been partially crushed and this apparent structure is probably due entirely to deformation. Similar observations have been made on lower Wolfcamp species of *Schwagerina*. Over 25 well preserved specimens were sectioned in an attempt to demonstrate the presence of cuniculi but in none of these could such a structure be demonstrated.

1:2.1. The form ratio of the first volution is 1:0.8 to 1:0.9, the form ratio decreases gradually with growth of the individual and the form ratio in the fifth and sixth volutions is 1:1.7 to 1:1.8.

The proloculum is small and its inside diameter measures 125 to 156 microns for six typical specimens, with an average inside diameter of about 140 microns for these same specimens. However, the proloculum of one of the figured specimens (fig. 7) has an inside diameter of only 78 microns and the proloculum of another of the figured specimens (fig. 10) has an inside diameter of 250 microns. The expansion of the shell is essentially uniform and the heights of the chambers in the first to the twelfth volution of two specimens average 41, 45, 54, 64, 75, 99, 100, 110, 148, 164, 159, and 150 microns, respectively.

The spirotheca is very thin and its thickness measures about 15 microns in the fifth volution, 15 microns in the eighth volution, 13 microns in the twelfth volution, and 18 microns in the fifteenth volution. Due largely to the numerous septula which hang from the lower part of the spirotheca, it is difficult to determine the true thickness of the spirotheca and the above figures probably are only close approximations of the true thicknesses. The spirotheca is composed of a thin outer layer, the tectum, and a thicker inner layer with fine parallel lines, the keriotheca.

The septa are thin and numerous. However, the septal count is difficult to obtain due partly to the large and numerous axial septula. In several specimens 25 to 28 primary septa were determined in the eleventh volution. Primary transverse septula occur throughout the shell and secondary transverse septula first appear in the seventh or eighth volution. Axial septula first appear in the fifth or sixth volution and there are about five axial septula between primary septa in the eleventh volution of mature specimens. Foramen are numerous, they occur throughout the shell, and their cross section is essentially circular. There are about 23 foramina in the eighth volution and 35 foramina in the twelfth volution. Parachomata are developed throughout the shell between the foramina.

Discussion.—*Y. minuta* resembles *Y. columbiana* rather closely but the former species is smaller in size at maturity, has fewer volutions at maturity, has a smaller number of foramina for corresponding volutions, expands more slowly with growth, and has a slightly different shell outline. Representatives of *Y. minuta* are very abundant in one of the larger cobbles obtained from Marble Canyon and no large specimens like the specimens of *Y. columbiana* have been found associated with the types of *Y. minuta* and we therefore feel reasonably sure that the specimens here referred to *Y. minuta* are not young specimens of *Y. columbiana*.

Occurrence.—This species is known only from the Marble Canyon limestone in Marble Canyon, southern British Columbia, where it is associated with an unidentifiable representative of *Schwagerina*.

Types.—Figured syntypes Stanford Univ. Paleo. Type Coll. No. 7331.

YABEINA COLUMBIANA (Dawson)
Plate 106, figure 5; Plate 107, figure 5; Plate 108, figure 1; Plate 109, figures 1–4

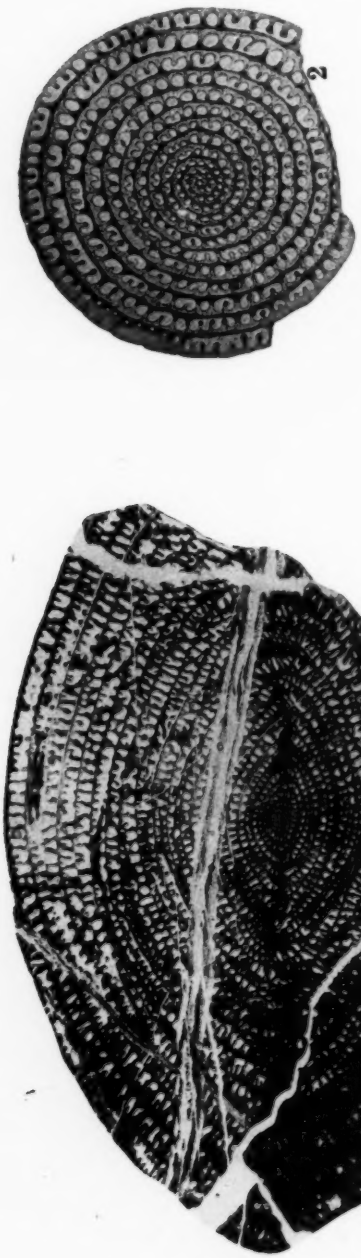
Loftusia columbiana DAWSON, *1879*, Quart. Jour. Geol. Soc. London, vol. 35, pp. 69–75, pl. 6, figs. 1–7.
Neoschwagerina cf. *craticulifera* STAFF, *1912*, Palaeontographica, Bd. 59, p. 161.
Neoschwagerina columbiana DUNBAR, *1932*, Royal Soc. Canada Proc. and Trans., 3d ser. vol. 26, Sec. IV, pp. 45–49, pl. 1, figs. 1–4.

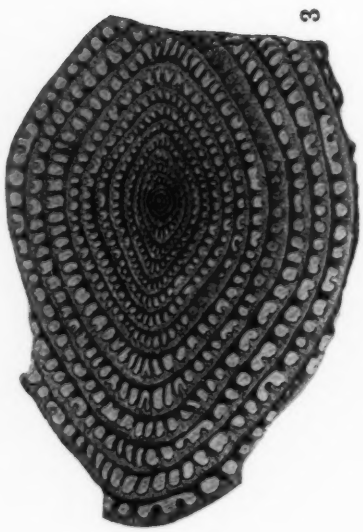
EXPLANATION OF PLATE 107

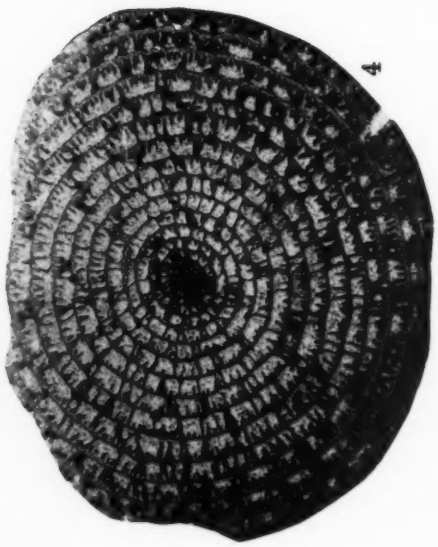
All original illustrations on this plate are unretouched photographs and all are magnified ×10.

FIGS. *1*—*Yabeina inouyei* Deprat. Syntype of the genotype of *Yabeina* Deprat, from the upper portion of the Permian limestone, Akasaka, Japan, ×10. (After Deprat)
2–4—*Yabeina packardi* Thompson and Wheeler, n. sp. *2*, Axial section; *3*, sagittal section; *4*, oblique tangential section showing the development of the axial and transverse septula. Permian limestone of central Oregon. (p. 710)
5—*Yabeina columbiana* (Dawson). Oblique tangential section which shows the development of the axial and transverse septula. Marble Canyon limestone. (p. 708)

Thompson and Wheeler, Permian Fusulinids







Thompson and Wheeler, Permian Fusulinids

Although Dawson's sections of this species clearly demonstrate its affinities with the subfamily Neoschwagerininae, much is left to be desired in regard to specific characters. We have obtained numerous well oriented sections of this species from the same locality as Dawson's original types and our specimens clearly are conspecific with the syntypes. The following description is based entirely on specimens in our collection from Marble Canyon.

Shell large, highly inflated; with bluntly pointed poles and straight axis of coiling. Mature specimens consist of seventeen to twenty-one volutions and measure 9.0 to 11.0 mm. in length and 5.3 to 6.9 mm. in width. The form ratio of mature specimens is 1:1.6 to 1:1.8, with an average form ratio of 1:1.7 for six typical specimens. The form ratio is about 1:1 for the first volution, but the mature shape of the shell is first attained in about the eighth volution where the form ratio is about 1:1.6.

The proloculum is minute and its inside diameter measures 94 to 140 microns, with an average inside diameter of about 112 microns for six specimens. The expansion of the shell is uniform and the heights of corresponding volutions in different specimens are very closely similar. The heights of the first to the twentieth volution of a typical specimen are 47, 62, 78, 94, 109, 125, 125, 140, 156, 172, 172, 172, 187, 190, 218, 218, 218, 234, 234, and 234 microns.

The spirotheca is thin. It is difficult to measure the thickness of the spirotheca, due largely to the numerous septula which hang from its lower surface. The alveoli of the spirotheca are very fine and extend downward only to the upper portion of the septula. In the fourteenth volution of a specimen of seventeen volutions the spirotheca measures about 14 microns.

Septa are numerous. There are 33 primary septa in the eighteenth volution of a specimen of twenty-one volutions. Primary transverse septula occur throughout the shell and secondary transverse septula first appear in the seventh or eighth volution. There are six axial septula between the septa in the sixteenth volution and seven axial septula between the septa in the twentieth volution.

The foramina are small and are only slightly elliptical, with the longest diameter of the cross section parallel to the axis of the shell. There are 39 to 44 foramina in the twelfth volution, 54 to 60 in the sixteenth volution, and 70 to 78 in the twentieth volution.

Discussion.—*Y. columbiana* can be distinguished from *Y. shiraiwensis* Ozawa by the much smaller proloculum, more irregular and longer axial septula, and apparently larger size of mature specimens of the former species. From Ozawa's illustrations of *Y. shiraiwensis* the spirotheca of that species appears to be more highly developed than the spirotheca of *Y. columbiana;* that is, the spirotheca seems to be thinner and the septula are more nearly pendant-like than with *Y. columbiana*. Also, *Y. multiseptata* (Deprat) contains a larger proloculum and has a much more highly developed spirothecal structure than *Y. columbiana*. *Y. columbiana* resembles *Y. inouyei* Deprat in general outline and shape. However, the latter species differs from the former especially in that the secondary transverse septula are better developed and, according to Deprat's description, it is larger at maturity but contains fewer volutions than *Y. columbiana*. It seems obvious, however, that these species biologically are very closely related. *Y. columbiana* closely resembles *Y. packardi*, described below. However, *Y. packardi* is shorter, more highly inflated at maturity, and contains better developed secondary transverse septula in the outer volutions.

Occurrence.—This species is known only

EXPLANATION OF PLATE 108

All original illustrations on this plate are unretouched photographs and all are magnified ×10.

FIGS. *1*—*Yabeina columbiana* (Dawson). Tangential section cut tangent to the second or third volution. Marble Canyon limestone. (p. 708)

2, 3—*Neoschwagerina craticulifera* (Schwager). Part of the original illustrations of the genotype of *Neoschwagerina* Yabe. *2*, Sagittal section, ×20; *3*, axial section, ×20. (After Schwager)

4—*Yabeina packardi* Thompson and Wheeler, n. sp. Sagittal section that is tangent to the outer part of the first volution. Permian of central Oregon. (p. 710)

from the Marble Canyon limestone from Marble Canyon, near Lillooet, British Columbia, where it is associated with *Schwagerina pavilionensis*, n. sp., *S. pavilionensis* var. *acris*, n. var., *Nankinella* (?) sp., and *Staffella* (?) sp.

Figured specimens.—Stanford Univ. Paleo. Type Coll., No. 7332.

YABEINA PACKARDI Thompson and Wheeler, n. sp.
Plate 106, figure 4; Plate 107, figures 2–4; Plate 108, figure 4

Shell large, highly inflated fusiform; with broadly rounded to bluntly pointed poles and straight axis of coiling. Mature specimens of seventeen to twenty volutions measure 8.1 to 10.6 mm. in length and 6.5 to 8.6 mm. in width. The form ratio of mature specimens is 1:1.2 to 1:1.4. The form ratio of the first volution is about 1:0.9. The mature shape of the shell is first reached in about the sixth volution where the form ratio is about 1:1.2.

The proloculum is minute. Its inside diameter measures 45 to 78 microns with an average inside diameter of about 55 microns. The shell expands uniformly to about the thirteenth volution, beyond which the expansion is slow and irregular. The averages of the heights of the first to the nineteenth volution of three typical specimens are 36, 47, 58, 85, 96, 145, 153, 160, 192, 203, 224, 250, 275, 270, 260, 296, 280, 296, and 280 microns, respectively.

The spirotheca is thin and is composed of a tectum and a keriotheca with fine alveoli. The alveoli extend downward to about the tops of the septula. The thickness of the spirotheca is difficult to determine because of numerous septula which hang from its lower portion. However, measurements made of the thickness of the spirotheca in the eighth to the nineteenth volutions give values of 11 to 25 microns, with these limits determined for almost any one of these volutions. It is obvious from the above figures that the spirotheca is thin.

The septa are thin and numerous. Because of the numerous axial septula, it is difficult to determine the septal count. However, 28 septa have been determined in the fifteenth and sixteenth volutions of several specimens. There are about 6 transverse septula in the fourteenth volution and 9 in the seventeenth volution between adjacent septa. Secondary transverse septula first appear in about the eight volution.

Foramina are essentially circular in cross section, and they are numerous. There are about 26 foramina in the tenth volution, 39 in the fourteenth volution and 56 in the eighteenth volution. Parachomata are well developed. They extend upward to the primary transverse septula in the inner ten to twelve volutions, but in the outermost volutions of mature specimens the parachomata do not reach the primary transverse septula near the midportion of the chambers. Axial fillings fill the chambers of the extreme polar regions from about the fifth to the nineteenth volution.

Discussion.—In regard to the general development of the shell, the development of the primary septula in the outer volutions of mature specimens, and the number and first appearance of secondary axial and transverse septula, *Y. packardi* resembles closely *Y. inouyei* Deprat, the genotype of *Yabeina*. However, *Y. packardi* is shorter, has a larger form ratio at maturity, has fewer foramen for corresponding volutions, and apparently has a slightly thicker spirotheca than *Y. inouyei*. It is probable that direct comparisons of typical material of these two species will show other differences. *Y. packardi* is shorter at maturity, has a larger form ratio at maturity, contains fewer foramina in corresponding volutions, contains more numerous axial septula for corresponding volutions, and contains more highly developed and longer secondary transverse septula than *Y. columbiana* (Dawson).

Occurrence.—The type specimens of *Y. packardi* were obtained from a cobble of limestone collected near the base of Gray Butte, Jefferson County, near Madras, Oregon.

Types.—Figured syntypes Stanford Univ. Paleo. Type Coll., No. 7333.

REFERENCES

CROCKFORD, M. B. B., and WARREN, P. S., *1935*, The Cache Creek series of British Columbia: *Royal Soc. Canada Proc. and Trans.*, 3d ser., sec. IV, vol. 29, pp. 149–161.

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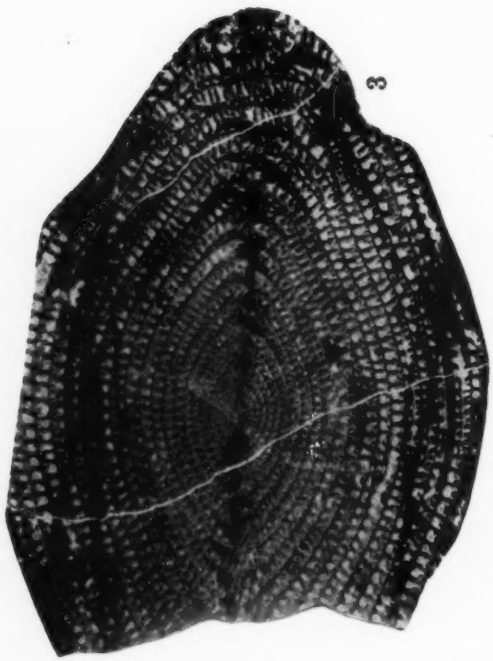

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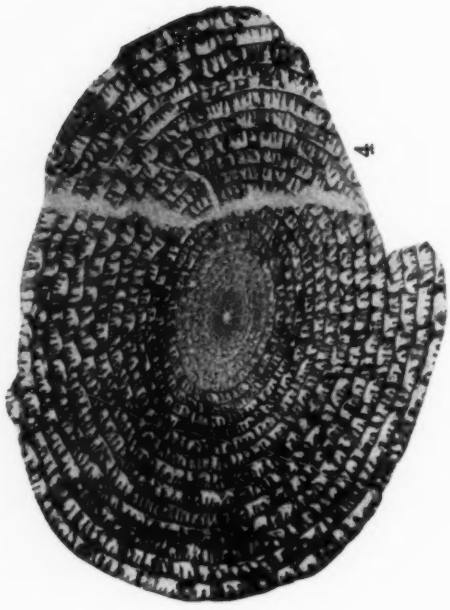

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Thompson and Wheeler, Permian Fusulinids

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DALY, R. A., *1915*, A geological reconnaissance between Golden and Kamloops, B. C., along the Canadian Pacific Railway: *Canada Dept. Mines, Geol. Survey Memoir* 68, No. 59, Geol. Series, pp. 120, 121.

DAWSON, G. M., *1879*, On a new species of Loftusia from British Columbia: *Geol. Soc. London Quart. Jour.*, vol. 35, pp. 69–75.

——, *1889*, Report on an exploration in the Yukon district, N. W. T., and adjacent northern portion of British Columbia; *Geol. and Nat. Hist. Survey Canada Annual Report*, n. s., vol. III, pt. 1, 1887–88, pp. 5B–277B.

——, *1896*, Report on the area of the Kamloops map-sheet, British Columbia: *Canada Geol. Survey Annual Report.*, n. s., vol. 7, 1894, pp. 26B, 39B, 40B.

DEPRAT, J., *1914*, Étude des fusulinidés du Japon, de Chine et d'Indochine et classification des calcaires a fusulines. III[e] Mémoire. Étude comparative des fusulinidés d'Akasaka (Japon) et des fusulinidés de Chine et d'Indochine: *Mém. Service Géol. de l'Indochine*, vol. III, fasc. 1.

DOUVILLÉ, H., *1934*, Le Permien marin de l'extrême-sud Tunisien. II. Les fusulinidés de la Tunisie: *Mém. Service Carte Geol. Tunisie*, n. s., no. 1, pp. 75–90.

DUNBAR, C. O., *1932*, *Neoschwagerina* in the Permian faunas of British Columbia: *Royal Soc. Canada Proc. and Trans.*, 3d ser., sec. IV, vol. 26, pp. 45–49.

——, *1941*, Permian faunas: A study in facies: *Geol. Soc. America Bull.*, vol. 52, pp. 328, 329.

HAYDEN, H. H., *1909*, Fusulinidae from Afghanistan: *India Geol. Survey Records*, vol. 38, pt. 3, pp. 230–256.

HUZIMOTO, H., *1936*, Stratigraphical and palaeontological studies of the Titibu system of the Kwanto-Mountainland. Part 1. Stratigraphy: *Tokyo Bunrika Daigaku Science Reports*, Sec. C., vol. 1, no. 4, pp. 157–188.

LEE, J. S., *1933*, Taxonomic criteria of Fusulinidae with notes on seven new Permian genera: *Mem. Nat. Research Inst. Geol.*, no. 14, pp. 1–32.

——, and CHAO, Y. T., *1924*, Geology of the Gorge District of the Yangtze (from Ichang to Tzekuei), with special reference to the development of the Gorges: *Geol. Soc. China Bull.*, vol. 3, pp. 351–391.

MILLER, A. K., and CROCKFORD, M. B., *1936*, Permian cephalopods from British Columbia: *Royal Soc. Canada Proc. and Trans.*, 3d ser., sec. IV, vol. 30, pp. 23–28.

——, and FURNISH, W. M., *1940*, Permian ammonoids of the Guadalupe Mountain region and adjacent areas: *Geol. Soc. America Special Paper* no. 26.

——, and WARREN, P. S., *1933*, A *Propinacoceras* from North America: *Am. Jour. Sci.*, 5th ser., vol. 26, pp. 295–299.

OZAWA, Y., *1927*, Stratigraphical studies of the Fusulina limestone of Akasaka, Province of Mino: *Tokyo Imp. Univ., Fac. Sci. Jour.*, sec. 2 (Geology), vol. 2, pt. 3.

SELWYN, A. R. C., *1872*, Journal and report of preliminary explorations in British Columbia: *Canada Geol. Survey Rept. Progress* 1871–72, p. 54.

SHEDD, SOLON, *1913*, Cement materials and industry in the State of Washington: *Washington Geol. Survey Bull.* 4, p. 231.

SMITH, G. O., and CALKINS, F. C., *1904*, A geological reconnaissance across the Cascade Range near the forty-ninth parallel: *U. S. Geol. Survey Bull.* 235, p. 22.

STAFF, HANS VON, *1912*, Monographie der Fusulinen. Teil III. Die Fusulinen (Schellwienien) Nordamerikas: *Palaeontographica*, Bd. 54, pp. 157–191.

THOMPSON, M. L., *1941*, Upper Permian fusulinid foraminifera from Afghanistan (Abstract): *Geol. Soc. America Proceedings* 1941.

TURNER, H. W., *1898*, Bidwell Bar Folio, California: *U. S. Geol. Survey Geological Atlas of the United States*, Folio 43, p. 3.

YABE, H., *1940*, Paleozoic formations of the Japanese Islands: *Sixth Pacific Sci. Cong. of the Pacific Sci. Assoc. Proceedings*, vol. 1, pp. 377–392.

MANUSCRIPT RECEIVED BY THE EDITOR NOVEMBER 11, 1941.

EXPLANATION OF PLATE 109

All illustrations on this plate are unretouched photographs and all are magnified ×10.

FIGS. *1–4*—*Yabeina columbiana* (Dawson). *1–3*, Axial sections; *4*, sagittal section. Marble Canyon limestone. (p. 708)

JOURNAL OF PALEONTOLOGY, VOL. 16, NO. 6, PP. 712–718, PL. 110, 1 TEXT FIG., NOVEMBER, 1942

OSTRACODES FROM THE UPPER PERMIAN OF TEXAS

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ABSTRACT.—An ostracode fauna is described from the upper Permian of the Glass Mts., Texas. The fauna is basal Guadalupe in age and dissimilar to small assemblages previously described from equivalent horizons. Five families are represented by eight genera. One genus and thirteen species are new.

Little is known concerning ostracodes from the later Permian in North America. The majority of the Permian formations younger than Big Blue and Wolfcamp are not known to contain ostracodes. Small faunas of ostracodes were described by Girty from the Phosphoria (1910, pp. 55–58), Bone Springs (1908, pp. 51–55), and the Delaware Mt. formation (1908, pp. 51–55) of the Rocky Mts. and trans-Pecos Texas; and by Branson from the Phosphoria (1930, p. 99) formation of the Middle Rocky Mts.

During the summer of 1941, Drs. G. A. Cooper and N. D. Newell collected a large quantity of blocks of limestone containing silicified fossils from the Permian formations of the Glass Mts., western Texas. While treating these samples with dilute hydrochloric acid, a small but excellently preserved fauna of silicified ostracodes was discovered at a single horizon in the basal Word formation, P. B. King's (1930, p. 143) Word limestone no. 1a. The rock from which the fauna was obtained consists of a fine-grained, dark brown to black bituminous limestone which occurs in discontinuous lenses in platy siliceous shale. Associated brachiopods and mollusks show evidences of concentration and minor reworking by currents or waves before burial.

FOSSIL LOCALITY.—The samples were collected from irregular lenses of bituminous limestone in siliceous shales, underlying the Word no. 1 and overlying siliceous Leonard shales exposed along a SW-NE trending scarp immediately north of the former Old Word Ranch house, in the Glass Mountains, 14 miles north, 26 degrees east of Marathon, Texas. The ranch house, which is now marked only by a sheep corral and water tank, stood 370 yards west of bench mark 5652 (See King and King, 1930).

FAUNAL CHARACTERISTICS.—The families *Leperditellidae*, *Kirkbyidae*, *Bairdiidae*, *Healdiidae*, and *Cytherellidae* are represented by thirteen species including the genera *Paraparchites*, *Kellettina*, *Kirkbya*, *Bairdia*, *Bythocypris*, *Healdia*, *Cavellina*, and the new genus *Alveus*. The *Bairdiidae* and *Kirkbyidae* dominate the fauna. The most common forms are exceptionally ornamented species of *Bairdia*. The *Healdias* are quite similar to common Pennsylvanian forms.

ACKNOWLEDGMENTS.—Acknowledgment is due to Drs. G. A. Cooper and N. D. Newell for use of material collected by them, and to Mrs. E. H. Nadeau for examining some of the type specimens.

SYSTEMATIC DESCRIPTIONS

Order OSTRACODA Latreille
Family LEPERDITELLIDAE
Ulrich and Bassler, 1906
Genus PARAPARCHITES Ulrich
and Bassler, 1906
PARAPARCHITES MARATHONENSIS
Hamilton, n. sp.
Plate 110, figure 12

Large, subovate, slightly oblique in lateral view; cardinal angles obtuse, the posterior one being slightly larger; dorsum convex centrally, flat at extremities; slight beak-like swelling in centrodorsal portion of right valve; posterior broadly rounded, anterior more sharply so with backward curvature varying with the specimen; venter broadly rounded; maximum length and height median; dorsal margin of left valve with prominent, straight groove receiving sharp edge of the right; inside margin of the right valve bevelled, more prominent ventrally, with a corresponding channeling of the outside margin of the left valve; inner lamellae conspicuous; surface smooth, unornamented except for a vertically projecting spine on the anterodorsal corner of the left valve.

Measurements.—Holotype, fig. 12a: length 2.52 mm.; height 1.82 mm. Figured specimen 12b: length 2.45 mm.; height 1.82 mm. Average for four specimens: length 2.29 mm.; height 1.66 mm.

Remarks.—This species is much larger than the average *Paraparchites* previously described.

Types.—Holotype, Wisconsin Univ. 22372; paratypes, Wisconsin Univ. 22384.

Family KIRKBYIDAE Ulrich and Bassler, 1906
Genus KIRKBYA Jones, 1859
KIRKBYA WORDENSIS Hamilton, n. sp.
Plate 110, figure 13

Subrectangular in lateral view; cardinal angles quadrangular; anterior margin sharply rounded with slight retral swing, posterior margin broadly convex; ventral outline concealed by an obscurely carinate inner flange, which is narrow to fairly broad, varying with the specimen and extending to cardinal angles, separated from a smaller carinate outer flange of five rows of reticulation pits at the broadest portion; outer flange becomes narrow centroventrally, both flanges converging at the cardinal angles; two nodes occur within the inner flange at the cardinal extremities, the posterior node obscure, the anterior one longer and terminating in a forward projecting spine; surface coarsely reticulate; a prominent horizontal ridge extends along center of valve connecting anteriorly with a very high, well-defined shoulder, projecting above hingeline and connecting posteriorly with a smaller shoulder which also projects above the hingeline, but to a lesser degree; a rather large oval kirkbyan pit occurs in a median position immediately below the horizontal ridge; just below the pit is another, less prominent ridge which roughly follows the false ventral outline of the valve and merges with the inner flange at the extremities well above mid-height; hinge typically kirkbyan.

Measurements.—Holotype: length 1.55 mm.; height 0.92 mm. Average of twelve specimens: length 1.45 mm.; height 0.87 mm.

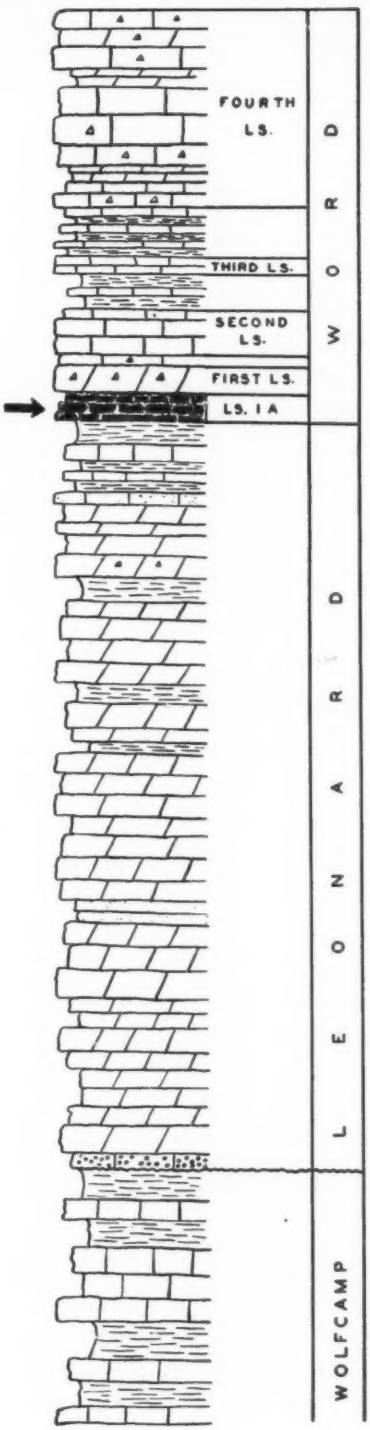

FIG. 1—Generalized section of the Word Ranch Permian, Glass Mts., Texas. Arrow indicates faunal horizon. (*After P. B. King*)

Remarks.—The ventral ridge is suppressed in immature molts gaining prominence with maturity. This is a much larger form than *Kirkbya wymani* Kellett, from the lower Permian, the elevated portion being more pronounced, and the pit smaller.

Types.—Holotype, Wisconsin Univ. 22373; paratypes, Wisconsin Univ. 22385.

Genus KELLETTINA Swartz, 1936
KELLETTINA VIDRIENSIS Hamilton, n. sp.
Plate 110, figure 9

Carapace elongate, relatively straight hinged; the posterocardinal angle approximately quadrangular, the anterior angle acute; posterior margin flatly convex, anterior margin with slight retral swing; ventral margin parallel to hinge; inner flange broad and smooth with row of reticulations at base, separated from a smaller outer flange by three or four rows of reticulations, both flanges converging and dying out at cardinal angles; surface with two prominent, elongate and reticulate nodes, the anterior node being the larger and extending above hingeline, each node has a vertical ridge from the apex to base; a smooth, circular pit on antero-ventral corner of the small posterior node.

Measurements.—Holotype: length 1.35 mm.; height 0.65 mm. Average of five specimens: length 1.42 mm.; height 0.66 mm.

Remarks.—Resembles *Kellettina robusta* (Kellett) from the lower Permian, but has a more prominent inner flange which departs noticeably from the plane of juncture of the valves.

Types.—Holotype, Wisconsin Univ. 22374; paratypes, Wisconsin Univ. 22386.

Superfamily CYPRIDACEA Dana, 1852
Family BAIRDIIDAE Sars, 1887
Genus BAIRDIA McCoy, 1844
BAIRDIA GUADALUPIANA Hamilton, n. sp.
Plate 110, figure 5

Elongate, subelliptical in lateral view; dorsal margin gently convex, sloping gradually to posterodorsal quarter thence truncated sharply to blunt beak at midheight; anterodorsal slope straight; anterior extremity sharply rounded, without abrupt break in convexity; venter concave centrally and convex towards the extremities, curving gently into truncate posterior, more sharply into anterior; maximum length at midheight; maximum height in anterior quarter; maximum thickness near center; left valve overlaps right all around margin, least con-

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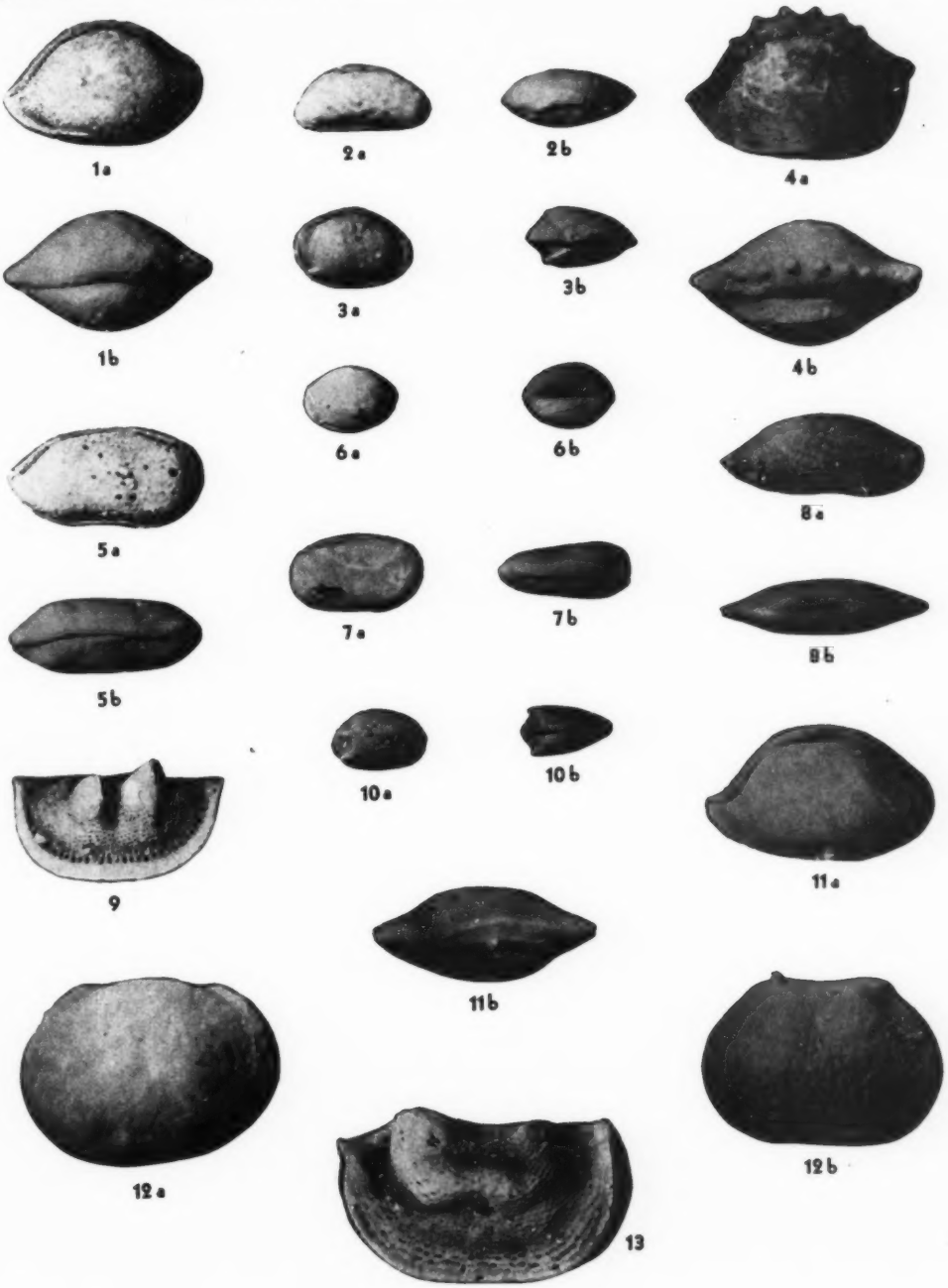
EXPLANATION OF PLATE 110

(All figures except 12a, b are ×25; 12a, b are ×15)

FIGS. *1a-b—Bairdia permiana* Hamilton, n. sp. *1a*, right valve showing sharply infolded venter. *1b*, dorsal view of holotype. (p. 715)
2a-b—Bythocypris sp? (p. 716)
3a-b—Healdia unispinosa Hamilton, n.s p.*3a*, right valve showing prominent overlap and postero-ventral spine. *3b*, dorsal view of holotype. (p. 717)
4a-b—Bairdia wordensis Hamilton, n. sp. *4a*, right valve with six dorsal spines and infolded venter. *4b*, dorsal view of holotype. (p. 716)
5a-b—Bairdia guadalupiana Hamilton, n. sp. *5a*, right valve showing concave venter. *5b*, dorsal view of holotype. (p. 714)
6a-b—Alvenus depressus Hamilton, n. sp. *6a*, right valve, adventitious material creates effect of ventral node. *6b*, dorsal view of holotype showing depressed hingeline. (p. 717)
7a-b—Cavellina ellipticalis Hamilton, n. sp. *7a*, left valve, anteroventral portion broken, *7b* dorsal view of holotype. (p. 717)
8a-b—Bairdia subfusiformis Hamilton, n. sp. *8a*, right valve, *8b*, dorsal view of holotype. (p. 716)
9—Kellettina vidriensis Hamilton, n. sp. Right valve of holotype showing ridges on nodes. (p. 714)
10a-b—Healdia vidriensis Hamilton, n. sp. *10a*, right valve. *10b*, dorsal view of holotype. (p. 716)
11a-b—Bairdia rhomboidalis Hamilton, n. sp. *11a*, right valve. *11b*, dorsal view of holotype showing slight ridge on left valve. (p. 715)
12a-b—Paraparchites marathonensis Hamilton, n. sp. *12a*, slightly rostrate right valve. *12b*, left valve of holotype showing spine; ventral portion of valve broken. (p. 712)
13—Kirkbya wordensis Hamilton, n. sp. Left valve of holotype showing anterior spine and prominent shoulders. (p. 713)



Hamilton, Permian Ostracodes

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spicuous on anterodorsal and posteroventral extremities; median areas of sides parallel in dorsal view, converging abruptly toward ends; hingeline sinuate, slightly depressed in middle third.

Measurements.—Holotype: length 1.25 mm.; height 0.65 mm.; thickness 0.50 mm. Average of five specimens: length 1.20 mm.; height 0.60 mm.; thickness 0.47 mm.

Remarks.—This species bears some resemblance to many common Pennsylvanian forms. It is larger, more elongate, and more nearly rectangular than *Bairdia altifrons* Knight from the Pennsylvanian. It differs from *Bairdia florenaensis* Upson, from the lower Permian, in having a more sharply concave venter, a higher and more acuminate posterior beak and is larger. Furthermore, it has a less abrupt posterior slope, a higher posterior beak and more prominent anterior beak than *Bairdia nevensis* Kellett, from the lower Permian.

Types.—Holotype, Wisconsin Univ. 22375; paratypes, Wisconsin Univ. 22387.

BAIRDIA RHOMBOIDALIS Hamilton, n. sp.
Plate 110, figure 11

Mature molts subrhomboidal, immature molts subelliptical in lateral view; dorsal margin highly arched, flattened in central portion dipping sharply to low posterior beak; antero-dorsal margin concave sloping less abruptly to slight anterior beak just above midheight; venter broadly convex gently rounding to posterior, more sharply to anterior; maximum length below midheight; maximum height at middle; maximum thickness central; left over right overlap prominent at dorsal and ventral margins, not apparent at anterior extremity; sides, in dorsal view, gently inflated in immature molts becoming essentially parallel with maturity, converging rather rapidly to extremities; slight ridge on dorsal part of left valve.

Measurements.—Holotype: length 1.45 mm.; height 0.85 mm.; thickness 0.60 mm.

Remarks.—Generally larger than *Bairdia powersi* Kellett, from the Pennsylvanian, with a convex ventral margin and a prominent dorsal overlap in mature molts. *Bairdia menardensis* Harlton, from the Pennsylvanian, lacks the dorsal ridge, is less nearly rhomboidal in outline, and has a less prominent dorsal overlap.

Types.—Holotype, Wisconsin Univ. 22376; paratypes Wisconsin Univ. 22388.

BAIRDIA PERMIANA Hamilton, n. sp.
Plate 110, figures 1a-b

Carapace subovate in lateral view; dorsal margin broadly arched, concave to anterior, flat to posterior beak; venter flat to slightly convex, curving gently to the posterior and more abruptly to the anterior portions; posterior beak acuminate just below midheight, anterior rather sharply rounded to blunt beak well above midheight; extreme ventral portion of right valve recedes abruptly into venter forming a rather prominent ridge when viewed laterally; maximum length and height median; maximum thickness central; left over right overlap greatest dorsally and in middle of venter- no apparent overlap on anterior and extreme rear portion of venter; surface very finely pitted; sides inflated in dorsal view converging gently and evenly to both ends; hingeline depressed in middle, slightly sinuate at extremities; in ventral view contact of valves strongly sinuate in anterior fourth.

Measurements.—Holotype: length 1.27 mm.; height 0.80 mm.; thickness 0.72 mm. Average for eight specimens: length 1.30 mm.; height 0.85 mm.; thickness 0.78 mm.

Remarks.—This species differs from *Bairdia deloi* Kellett, lower Permian, in having a flat or nearly flat ventral outline and a lower posterior beak; from *Bairdia crassa* Harlton, Pennsylvanian, and *Bairdia plebeia* Reuss, Carboniferous and Permian, in possessing a ventral ridge-forming right valve. Except for the lack of dorsal spines and a slightly smaller carapace, *B. permiana* closely resembles *B. wordensis* n. sp. Both are common in the basal Word. It is possible that *B. permiana* is the gerontic form of *B. wordensis* or the latter may be the ornamented male. However, until the life relationships of the *Bairdias* are understood more fully, it seems best to designate the two forms as separate species.

Types.—Holotype, Wisconsin Univ. 22377; paratypes, Wisconsin Univ. 22389.

BAIRDIA SUBFUSIFORMIS
Hamilton, n. sp.
Plate 110, figure 8

Slender, elongate; dorsal margin broadly convex; posterodorsal slope slightly concave, anterodorsal slope straight to gently concave; posterior beak acuminate just below midheight, anterior beak blunt, lying above midheight; venter concave medially, curving flatly to posterior beak and more sharply to anterior extremity; maximum length median; maximum height just in front of middle; maximum thickness central; left valve overlaps the right all around margin, least conspicuous at extremities; surface smooth; thin, subfusiform in dorsal view, sides converge gently to posterior, more abruptly to anterior; hingeline straight, recurved at anterior extremity.

Measurements.—Holotype: length 1.30 mm.; height 0.52 mm.; thickness 0.35 mm. Average of four specimens: length 1.33 mm.; height 0.55 mm.; thickness 0.37 mm.

Remarks.—Similar to *Bairdia plebeia* var. *elongata* Reuss, Permian of England, however, the dorsal margin of the latter is more strongly arched and the venter is only slightly concave.

Types.—Holotype, Wisconsin Univ. 22378; paratypes, Wisconsin Univ. 22390.

BAIRDIA WORDENSIS Hamilton, n. sp.
Plate 110, figure 4

Subtriangular in lateral view; dorsal margin broadly arched, the anterodorsal and posterodorsal slopes gently concave; venter flat, rounding abruptly to ends; posterior beak acuminate at midheight; anterior beak in mature molts corresponds to a short forward projecting spine well above midheight; maximum length and height median; left over right overlap prominent dorsally and in middle of venter, least conspicuous on front and rear part of venter; surface finely pitted; very obese in dorsal view, rounded in central third, the sides converging sharply to ends; hingeline sinuate, depressed in middle third; the centrodorsal portion of the right valve flattens abruptly to hingeline, expressed as a flat terrace in dorsal view and as a rather prominent ridge in lateral view; the dorsal surface of the left valve is usually ornamented by two to seven short strong spines equally spaced and concentrated dorsally on the middle third or more; the ventral portion of the right valve sharply infolded, forming a sharp downward projecting ridge terminating in mature molts as a backward projecting spine.

Measurements.—Holotype: length 1.45 mm.; height 0.92 mm.; thickness 0.80 mm. Average of eight specimens: length 1.45 mm.; height 0.90 mm.; thickness 0.85 mm.

Remarks.—Very common in the basal Word, the unusual ornamentation easily differentiates this species from previously described *Bairdias.*

Types.—Holotype, Wisconsin Univ. 22379; paratypes, Wisconsin Univ. 22391.

Genus BYTHOCYPRIS Brady, 1880
BYTHOCYPRIS sp.
Plate 110, figure 2

Elongate, subovate in lateral view; dorsal margin broadly convex; anterior rather sharply rounded; posterior straight to gently curved from low beak, rounding sharply to dorsum; venter straight to slightly concave; maximum length immediately below midline; maximum height median or submedian, maximum thickness in posterior third; left over right overlap slight, fairly even and entire; surface smooth.

Measurements.—Figured specimen: length 0.85 mm.; height 0.40 mm.; thickness 0.37 mm.

Remarks.—This form is rather rare in the basal Word, preservation is too poor for specific determination.

Family HEALDIIDAE Harlton, 1933
Genus HEALDIA Roundy, 1926
HEALDIA VIDRIENSIS Hamilton, n. sp.
Plate 110, figure 10

Subtriangular in lateral view, rather short; dorsal margin arched, sharply rounded just behind middle, antero- and posterodorsal slope almost straight; venter gently convex, truncated posteriorly, rounding abruptly into anterior; maximum length along midline; maximum height just behind middle; maximum thickness in posterior quarter; left valve evenly overlaps the right all around except on posterodorsal slope; bullet-shaped in dorsal view; gently inflated, with maximum thickness at posterior end of

shoulder; a long prominent ridge, vertically shoulder-like in lateral view, bears two strong spines, the lower of which usually is more prominent; surface smooth.

Measurements.—Figured specimen: length 0.60 mm.; height 0.35 mm.; thickness 0.32 mm. Average of five specimens: length 0.59 mm.; height 0.36 mm.; thickness 0.32 mm.

Remarks.—Spines much more prominent than *Healdia winfieldensis* Upson, lower Permian, and the posterior part of dorsum is not depressed.

Types.—Holotype, Wisconsin Univ. 22380; paratypes, Wisconsin Univ. 22392.

HEALDIA UNISPINOSA Hamilton, n. sp.
Plate 110, figure 3

Subelliptical in lateral view; dorsal margin broadly arched, curving evenly to extremities; anterior extremity narrow and sharply rounded; posterior broad, curving abruptly to venter from beak which lies well above midheight; venter flat to gently concave; maximum length along line in dorsal third; maximum height near middle; maximum thickness in posterior third; left valve strongly overlaps right all around, less conspicuous on antero- and posterodorsal extremity; bullet-shaped in dorsal view, gently inflated; the prominent posterior shoulder bears a strong ridge with a posteroventral, lance-like spine on right valve; surface smooth.

Measurements.—Holotype: length 0.75 mm.; height 0.50 mm.; thickness 0.42 mm. Average of four specimens: length 0.71 mm.; height 0.49 mm.; thickness 0.39 mm.

Remarks.—This species differs from *Healdia squamosa* Harlton, Pennsylvanian, in that the beak of the former is in the dorsal quarter of the carapace and the dorsal border rounds evenly into extremities.

Types.—Holotype, Wisconsin Univ. 22381; paratypes, Wisconsin Univ. 22393.

Family CYTHERELLIDAE Sars, 1866
Genus CAVELLINA Coryell, 1928
CAVELLINA ELLIPTICALIS Hamilton, n. sp.
Plate 110, figure 7

Subelliptical in lateral view; dorsal margin gently arched; anterior evenly and bluntly rounded, posterior more sharply rounded, with rather prominent beak well above midheight; ventral margin slightly concave, rounding sharply into posterior, gently into the anterior extremity; right valve overlaps left all around, less conspicuous a extremities; maximum length midway between dorsum and venter; maximum height just behind middle; maximum thickness in posterior third; surface smooth; sides in dorsal view converge gently to anterior, abruptly into thickened posterior; hingeline sinuate in anterior third; dorsal margin of right valve raised into broad ridge.

Measurements.—Holotype: length 0.90 mm.; height 0.50 mm.; thickness 0.40 mm.

Remarks.—Similar to *Cavellina pulchella* Coryell, from the Pennsylvanian, but does not have the convex dorsal and ventral border of the latter. This is a larger form than *Cavellina edmistonae* (Harris and Lalicker), from the upper Pennsylvanian and lower Permian. Rare in the basal Word.

Types.—Holotype, Wisconsin Univ. 22382; paratypes, Wisconsin Univ. 22394.

Genus ALVEUS Hamilton, n. gen.

Small, subelliptical ostracodes with dorsal margin broadly to sharply arched, ends rounded; immature molts with slight backward swing, mature molts bilaterally symmetrical; left valve bevelled to receive thin sharp edge of right, no apparent dorsal overlap; hingeline long, straight, prominently depressed along entire length; maximum length above midheight; surface smooth to very finely granulose, unornamented.

Alveus differs from *Microcheilinella* Geis in general outline, greater symmetry, and a more pronounced dorsal depression.

Genotype.—*Alveus depressus* Hamilton, n. sp.

ALVEUS DEPRESSUS Hamilton, n. sp.
Plate 110, figure 6a-b

Carapace small, subelliptical in lateral view; dorsal outline gently convex in immature molts, becoming sharply arched with maturity; anterior margin sharply rounded with slight backward swing in immature molts; posterior margin slightly less sharply rounded; venter convex; maximum length

above midheight; maximum height median; maximum thickness central; left valve slightly overlaps right all around margin except dorsally where valves are apparently equal; very obese in dorsal view, sides rounding evenly to both extremities; hingeline straight, deeply depressed.

Measurements.—Holotype: length 0.50 mm.; height 0.37 mm.; thickness 0.37 mm. Average of five specimens: length 0.48 mm.; height 0.35 mm.; thickness 0.35 mm.

Types.—Holotype, Wisconsin Univ. 22383; paratype, Wisconsin Univ. 22395.

REFERENCES

BRANSON, C. C., *1930*, Paleontology and Stratigraphy of the Phosphoria Formation: *Missouri Univ. Studies*, vol. 5, no. 2, p. 99.

GIRTY, G. C., *1908*, The Guadalupian Fauna: *U. S. Geol. Survey Prof. Paper* 58, pp. 51–55.

——, *1910*, The Fauna of the Phosphate Beds of the Park City Formation in Idaho, Wyoming, and Utah: *U. S. Geol. Survey Bull.* 436, pp. 55–58.

KING, PHILIP B., *1930*, The Geology of the Glass Mountains, Texas: *Univ. of Texas Bull.* no. 3038, Part 1, p. 143.

——, and KING, R. E., *1930*, Geologic Map of the Glass Mountains, *Univ. of Texas Bull.* no. 3038, Part 1.

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PERMIAN NAUTILOIDS FROM WESTERN UNITED STATES

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ABSTRACT.—In this study, representatives of the following genera of nautiloids are described from the Permian of western United States: *Coelogasteroceras* from Wyoming; *Metacoceras*, *Aulametacoceras* [n. gen.], *Tainoceras*, *Titanoceras*, and *Domatoceras* from the Arizona-New Mexico region; and *Stenopoceras* from Kansas. Also, there is included a description of a new species of *Tainoceras* from the Pennsylvanian of Oklahoma. It is concluded that our present knowledge of Permian nautiloids does not enable us to use them satisfactorily for detailed correlation.

RELATIVELY few nautiloid cephalopods are known from the Permian, in comparison with the rest of the Paleozoic. As a matter of fact, after Pennsylvanian times nautiloids were not abundant, with a few notable exceptions such as *Eutrephoceras* in the Cretaceous and *Cimomia* and *Hercoglossa* in the Paleocene. This general stratigraphic distribution contrasts strongly with that of the ammonoids, and of course suggests that the two groups are mutually complementary.

With the active coöperation of several colleagues over a period of some five years, we have assembled a good many Permian nautiloids from western United States. These come from widely separated localities, and, although none of them is particularly important in itself, collectively they add greatly to our knowledge of this group during the closing stages of the Paleozoic. We want to take advantage of this opportunity to acknowledge our indebtedness to the following for the loan or gift of specimens: Messrs. L. F. Brady and Edwin D. McKee of the Museum of Northern Arizona, Byron N. Cooper of the University of Wichita, Alfred G. Fischer of the Virginia Polytechnic Institute, Don B. Gould of Colorado College, A. N. Murray of the University of Tulsa, Stuart A. Northrop of the University of New Mexico, Louis Schellbach of the Grand Canyon National Park, H. D. Thomas of the University of Wyoming, and H. G. Walter of the Ohio Oil Company. Acknowledgment is also due to Mr. Howard Webster who retouched the photographs that accompany this report and prepared part of the text figures.

The only nautiloid faunas that have been recorded previously from the Permian of the United States came from the lower portions of that system in eastern Kansas and central Texas. In 1858 Swallow described, but did not illustrate, the following four species which Major Frederick Hawn had collected in Kansas:

Mooreoceras kickapooense (Swallow)
"*Cyrtoceras*" *dorsatum* Swallow
Metacoceras? permianum (Swallow)
Tainoceras occidentale (Swallow)

The first three of these came from "near Smoky-Hill Fork," the last from "the valley of the Cotton-wood." Somewhat later, Meek and Hayden added "*Nautilus*" *eccentricus* Meek and Hayden from the former (or a near-by) locality. Then, in 1891 Hyatt published illustrations and descriptions of some nautiloids which Mr. Robert Hay and Captain George E. Pond had collected near Junction City, Kansas, presumably from the Fort Riley limestone:

Metacoceras dubium Hyatt
M. hayi Hyatt
M. inconspicuum Hyatt
Stenopoceras dumbli (Hyatt)

The occurrence of *Stenopoceras* in the Florena shale of Cowley County, Kansas, was recorded by Miller and Thomas (1936, p. 736); and another representative of that genus, *S. cooperi*, n. sp., has recently been sent to us from the Lower Permian Neva limestone near Grand Summit, Kansas.

In 1891 Charles A. White illustrated and described a considerable cephalopod fauna from the Clyde formation near the "Old Military Crossing" in Baylor County, Texas. This included the following nautiloids:

Mooreoceras sp.
Liroceras sp.
"*Nautilus* (*Endolobus*) ——?"
Temnocheilus aff. *T. winslowi* (Meek and Worthen)
Tainoceras occidentale (Swallow)?
Stenopoceras sp.

Two years later, Hyatt described five species from the same horizon and locality:

Liroceras globulare (Hyatt)
Endolobus conchiferous (Hyatt)
Metacoceras? militarium (Hyatt)
M.? simplex (Hyatt)
Tainoceras aff. *T. quadrangulum* McChesney

At the same time, Hyatt described a somewhat similar fauna from Ballinger, Texas, presumably from the Lueders formation:

Endolobus aff. *E. coxanus* (Meek and Worthen)
Metacoceras? simplex (Hyatt)
Tainoceras cavatum Hyatt
Solenochilus aff. *S. collectus* Meek and Worthen

The collections of the State University of Iowa contain a fragmentary representative of *Temnocheilus* which Lloyd C. Mills found in the Elm Creek limestone of the Wichita group, about 1 mile east of Baird, Callahan County, Texas; and similar representatives of *Mooreoceras* and *Domatoceras* which W. M. Furnish collected from the Guthrie dolomite of the Double Mountain group at the falls on Salt Croton Creek in Stonewall County, Texas.

Many years ago, Shumard (1859, pp. 399–400) mentioned that both straight and coiled nautiloids occur in the Permian strata of the Guadalupe Mountains of west Texas. In his monograph on the Guadalupe fauna, published in 1908, Girty described only three species of nautiloids:

Mooreoceras? quadalupense (Girty)
Metacoceras shumardianum (Girty)
Parametacoceras praecursor (Girty)

The first of these came from the Delaware Mountain formation, the second from the Capitan, and the third from the Bone Spring. It should be emphasized that nautiloids are not as rare in the abundantly fossiliferous Permian strata of west Texas as the published data would seem to indicate, but they have not been collected or studied as diligently as have the well-known ammonoids, which are generally believed to have much greater stratigraphic value. For example, Miller and Furnish in their recent report on the Guadalupe ammonoids stated: "Nautiloids, which have heavier shells than ammonoids, are relatively abundant in the more massive limestones."

The prolific Permian faunas of southwestern Coahuila, like those of west Texas, contain many ammonoids but only a few nautiloids. A new species of *Bitauniceras* occurs in the Leonard, Word, and Capitan equivalents there. Also, an unnamed representative of *Titanoceras* has been found in the beds of Word age, and the Capitan equivalent has yielded *Liroceras?* sp. and *Stearoceras* sp. It should also be mentioned that *Bactrites*, which is regarded by some as a nautiloid but by others as a primitive ammonoid, occurs in both the Leonard and the Capitan beds of Coahuila.

Only a few cephalopods are known from the Phosphoria formation (and the equivalent Satanka shale) of Wyoming, but several types of nautiloids have been found there:

Mooreoceras? sp.
Coelogasteroceras thomasi Miller and Cline
C. mexicanum (Girty)
C. sp.
Stearoceras phosphoriense (Branson)
S. sp.

Also, Dr. H. D. Thomas recently sent us several representatives of *Coelogasteroceras mexicanum* (Girty) from the Minnekahta limestone of the Shirley Mountains of southeastern Wyoming. It should perhaps be mentioned here that Miller and Crockford have illustrated a representative of *Mooreoceras* from the Cache Creek series of southern British Columbia, which is probably of about the same age as the Phosphoria.

Some years ago Hyatt described a typical representative of *Tainoceras*, *T. duttoni* Hyatt, from the Chupadera formation? near Grants, in northwestern New Mexico. Professor Stuart A. Northrop recently sent us for study a collection of nautiloids from the Chupadera near Bluewater Dam, about 16 miles northwest of Grants; this collection consists of a fragmentary specimen that is probably referable to *Mooreoceras* and the forms described below as *Domatoceras northropi*, n. sp., *Metacoceras* cf. *M. biseriatum*, n. sp., and *Metacoceras? aberrans*, n. sp.

In 1909 Girty described representatives of *Mooreoceras* and *Temnocheilus?* from the Abo sandstone of central New Mexico. He also described the following nautiloids from the Yeso formation in the same general area:

Coelogasteroceras mexicanum (Girty)
Endolobus aff. *E. conchiferous* (Hyatt)
Temnocheilus aff. *T. winslowi* (Meek and Worthen)
T.? sp.
Domatoceras? sp.

At the same time Girty indicated that *Endolobus* aff. *E. conchiferous* (Hyatt) and *Temnocheilus?* sp. occur in the San Andres formation in central New Mexico. Locally, nautiloids are abundant in this formation, in southeastern New Mexico; the available collections contain fragmentary representatives of several quite distinct types but only four recognizable species:

Titanoceras rotundatum, n. sp.
T. sanandreasense Miller, Dunbar, and Condra
Domatoceras bradyi, n. sp.
D. walteri, n. sp.

No cephalopds have been described previously from the Permian of Arizona, though lists published by Darton (1925, pp. 87, 103, 104) indicate that coiled nautiloids occur in both the Supai and the Kaibab formations, and McKee has recently illustrated a Kaibab specimen. Messrs. L. F. Brady, Edwin D. McKee, Louis Schellbach, and Don B. Gould have sent us numerous specimens from the Kaibab formation in the general vicinity of Flagstaff. These include the following nautiloids:

Mooreoceras sp.
Metacoceras biseriatum, n. sp.
Aulametacoceras mckeei, n. sp.
Tainoceras schellbachi, n. sp.
Titanoceras cf. *T. rotundatum*, n. sp.
T. cf. *T. sanandreasense* Miller, Dunbar, and Condra
Domatoceras bradyi, n. sp.

Also, *Tainoceras duttoni* Hyatt occurs in the Toroweap formation, which immediately underlies the Kaibab.

One of the largest Permian nautiloid faunas known is from the Bitauni beds of Timor, which are of approximately the same age as the Leonard formation of west Texas. A few nautiloids have also been found in the other Permian strata of that island, and altogether the following forms are known from there:

Somohole beds
Liroceras? sp.
Bitauni beds
Neorthoceras verbeeki (Haniel)
N.? welteri (Haniel)
Bitauniceras bitauniense (Haniel)
"Orthoceras" maubesiense Haniel
Liroceras brouweri (Haniel)
L.? molengraaffi (Haniel)
L.? sp.
Coelogasteroceras wanneri (Haniel)
Foordiceras? sp.
Domatoceras arthaberi (Haniel)
"Aganides" bitauniensis (Haniel)
(?) *Bactrites* sp.
Basleo beds
Neorthoceras verbeeki (Haniel)
Foordiceras dyadicum (Haniel)
Amarassi beds
Foordiceras dyadicum (Haniel)
Domatoceras arthaberi (Haniel)

It should also be mentioned in this connection that Fliegel has illustrated and described several nautiloids from the Lower Permian of Sumatra:

Mooreoceras? orientale (Fliegel)
Metacoceras aff. *M. hayi* Hyatt
Foordiceras lóczyi (Fliegel)
F. sumatrense (Fliegel)

Another extensive fauna of Permian nautiloids, which is also the youngest one, is from the Salt Range of India. Waagen has described two rather closely related assemblages from there. The older of these came from the Middle *Productus* limestone and consists of the following species:

"Orthoceras" punjabiense Waagen
Metacoceras? medlicottianum (Waagen)
Foordiceras flemingianum (de Koninck)
Domatoceras connectens (Waagen)
D. opnioneus (Waagen)
Stenopoceras? peregrinum (Waagen)

The younger Permian nautiloid assemblage described by Waagen from the Salt Range came from the Upper *Productus* limestone. It is composed of the following:

"Orthoceras" sp.
Brachycycloceras? cyclophorum (Waagen)
B.? oblique-annulatum (Waagen)
Foordiceras goliathum (Waagen)
F.? latissimum (Waagen)

F. transitorium (Waagen)
F. wynnei (Waagen)
Temnocheilus multituberculatum (Waagen)
Domatoceras convolutum (Waagen)

Both of these assemblages differ from those known from America, which is perhaps to be explained by their age and by the remoteness of the locality from which they came. It should also be mentioned here that Diener has described a typical representative of *Domatoceras*, *D. hunicum* (Diener), from the Upper Permian limestone crag of Chitichun No. 1 in the central Himalayas. Furthermore, Suess, basing his statements on fossils collected by Ferdinand Stoliczka and studied by Mojsisovics, reported the occurrence of "*Orthoceras*" and *Domatoceras* aff. *D. convolutum* (Waagen) in the Permian marble north of the Karakoram Pass in northern India close to the Tibetan border.

The literature on the Permian of China is scattered and is difficult to interpret, but certain contributions should perhaps be noted. In 1883 Kayser described several species of Permian nautiloids which von Richthofen obtained at the famous Loping locality in northeastern Kiangsi (east-central China):

"*Orthoceras*" spp.
Liroceras? sp.
Tainoceras mingshanense (Kayser)
T. orientale (Kayser)

From the Paotechou limestone of western Shansi (northeastern China) Grabau records the following nautiloids:

Metacoceras sp.
Temnocheilus asiaticus Grabau
"*Huangoceras simplicostatum* Grabau"
Domatoceras subquadrangulare (Grabau)

The extensive Permian deposits of Soviet Russia have yielded many nautiloids. However, the literature is so scattered and much of it is so difficult to obtain, that our lists are probably far from complete. Kruglov and others have described the following forms from the Artinskain beds of the Ural region:

Liroceras? sarvaensis (Kruglov)
"*Stroboceras*" sp.
Metacoceras piszovi artiense Kruglov
M. spinosum Kruglov
M.? aff. *M.? uralicum* (Fredericks)
Temnocheilus posttuberculatus (Karpinsky)
T. posttuberculatus kosswae Kruglov
T. posttuberculatus waschkuricus Kruglov
Domatoceras fredericksi Kruglov
D. krotovi (Kruglov)
D.? sp.
Solenochilus aff. *S. collectus* Meek and Worthen

It should also be mentioned that Kruglov has described *Domatoceras krotovi* (Kruglov) and *D. fredericksi* Kruglov from the Kungurian beds of the Ural region, and that he has recorded the occurrence of *Tainoceras* and another genus of coiled nautiloids in the Permian? of the Ussuri region near Vladivostok. The Middle Permian dolomite beds of the Donetz Basin in the southern part of European Russia carries a considerable nautiloid fauna; the collections of Boris Licharew in Leningrad contain typical representatives of *Foordiceras* from there, and Jakowlew had described the following forms from the same general horizon and locality:

Mooreoceras kodimae (Jakowlew)
Liroceras? sp.
L.? korulkensis (Jakowlew)
Metacoceras grewingki (Tschernyschew)?
M. pernodosum (Tschernyschew)?
M. trigonotuberculatum Jakowlew
Temnocheilus cf. *T. crassus* Hyatt
Titanoceras? variabile (Jakowlew)
Domatoceras? nikitowkensis (Jakowlew)

Licharew and Kruglov have illustrated representatives of *Liroceras?*, *Permonautilus*, and *Domatoceras* from the "Upper Permian" of the Vaga, Pinega, and Kuloi river basins in the north-central portion of European Russia. Probably the most varied fauna of Permian nautiloids that has so far been described came from the Upper Permian beds near Djoulfa in Armenia. Unfortunately there is much difference of opinion in regard to the age of these beds and to the specific identity of the fossils contained in them. Nevertheless, it is clear from the published illustrations that at least the following nautiloid genera are represented there: "*Orthoceras*," *Liroceras?*, *Permonautilus*, *Metacoceras*, *Foordiceras*, *Tainoceras?*, and *Domatoceras*. Although this assemblage of genera might seem to suggest a relationship to American faunas, the species are not closely similar and are much more like those known from the Upper Permian of India. This variance from American faunas is

probably due to difference in age as well as to geographic position.

The Upper Permian *Bellerophon* limestone of the southern part of the eastern Alps has yielded a good many nautiloids which have been described by Diener, Merla, and others. It is now clear that at least *"Orthoceras," Liroceras, Foordiceras, Metacoceras,* and *Tainoceras* are represented there. Simić has illustrated and described a few nautiloids from the Upper Permian of western Serbia which appear to be referable to *"Orthoceras," Temnocheilus,* and *Tainoceras.* From farther south, in Sicily, we know through the work of Gemmellaro and Greco several species of *"Orthoceras"* and *Bactrites* as well as the following coiled nautiloids:

Temnocheilus gemmellaroi Canavari
Foordiceras? nodoso-costatum (Gemmellaro)
F. pleuronautiloides (Gemmellaro)
Tainoceras toulai (Gemmellaro)
Liroceras salomonensis (Gemmellaro)

Of these three southern European faunas, only the Sicilian is well known, and it is surprisingly like those that occur in the American Permian. However, with the exception of straight forms, which are very difficult to interpret, nautiloids are exceedingly rare in the Permian of Sicily.

These several lists seem to indicate that our present knowledge of Permian nautiloids does not enable us to use them satisfactorily for detailed correlation. Almost all of the genera occur also in the Pennsylvanian, and at least one ranges into the Triassic. Several of the Pennsylvanian-Permian genera, for example, *Metacoceras, Tainoceras,* and *Domatoceras,* are almost world-wide in their distribution, but *Foordiceras,* which is widespread in the Permian of Eurasia, is not known to occur in the western hemisphere.

SYSTEMATIC PALEONTOLOGY

COELOGASTEROCERAS MEXICANUM (Girty)

Plate 111, figures 1–6; Plate 112, figures 3, 4

Coloceras mexicanum GIRTY, *1909,* U. S. Geol. Survey Bull. 389, p. 113, pl. 12, figs. 1–1b.
Coelogasteroceras mexicanum MILLER, DUNBAR, and CONDRA, *1933,* Nebraska Geol. Survey Bull. 9, 2d. ser., p. 212.
Coelogasteroceras mexicanum MILLER and CLINE, *1934,* Jour. Paleontology, vol. 8, p. 287.

Recently H. D. Thomas sent us eight nautiloids from the Minnekahta limestone of the Shirley Mountains, Wyoming, which are the only cephalopods known from that formation. All of these are closely similar and are probably conspecific. Furthermore, insofar as we can tell from the literature, they can not be differentiated specifically from *Coelogasteroceras mexicanum* (Girty) of the Yeso formation of central New Mexico.

The largest of these specimens is estimated to have attained a diameter, measured accross the unbilicus, of some 50 mm. Near the adoral end of this large specimen the maximum height and width of the conch measure about 25 mm. and 35 mm., respectively. The umbilical shoulders are fairly abrupt, but the ventrolateral zones of the conch are narrowly rounded. The diameter of the umbilicus is equal to about one-third that of the specimen. The umbilical walls are almost parallel to the axis of coiling. The lateral zones of the conch are considerably flattened and they converge ventrad. The ventral zone is distinctly concave medianly.

One of the Minnekahta specimens (pl. 111, figs. 5, 6) retains much of the test. The surface of the test bears rather prominent oblique ventrolateral nodes, which are considerably elongate and which slope orad from the venter. The long axis of these nodes is parallel to the growth lines, which form a deep rather narrowly rounded ventral sinus and which curve decreasingly orad between the ventrolateral and the dorsolateral shoulders.

Three of the specimens bear very distinct longitudinal lirae. In one case these are located in the impressed dorsal zone of the conch, and in the other cases they are on the lateral zones. They seem to be developed on an inner layer of the test, but this conclusion needs verification.

The sutures are in general directly transverse, but they form slight ventral, lateral, and dorsal lobes. These lobes are separated by somewhat narrower saddles. The siphuncle is small and is located fairly close to the dorsal wall of the conch. Where the phragmacone is about 21.5 mm. wide and 12 mm. high, and is impressed to a depth of about 2 mm., the siphuncle is about 1 mm. in diameter and is located about 7.7 mm. from the venter and about 1.5 mm. from the dorsum.

Remarks.—Superficially the specimen from the Satanka shale of Red Mountain, Wyoming, southeast of the Shirley Mountains, which Miller and Cline described as *Coelogasteroceras* sp. is similar to the form under consideration. However, a structure that appears to represent its siphuncle is central (or nearly so) in position.

Very recently Alfred G. Fischer sent us two specimens from the lower portion of the Phosphoria formation (immediately beneath the "lower phosphate") west of Lander, Wyoming, which are probably conspecific with the Minnekahta form. One of these represents only part of one whorl, but the other (pl. 112, figs. 3, 4) is an excellent specimen a little more than 50 mm. in diameter.

Representatives of *Coelogasteroceras* are now known from the Mississippian of Indiana and possibly Arkansas, the lower Pennsylvanian of England and possibly Wales, and the Middle Permian of New Mexico, Wyoming, and Timor. However, the species under consideration is closely similar to only *C. thomasi* Miller and Cline of the Ervay tongue of the Phosphoria formation in the Rattlesnake Hills, central Wyoming. In that species the ventral zone of the conch is only very slightly concave, and the rate of adoral expansion of the conch is relatively great. Also, the siphuncle is central, or nearly so, in position.

Occurrence.—All eight of the above-described specimens were collected by H. D. Thomas from the lower part of a ten-foot limestone member of the Minnekahta formation (about 73 feet above the Tensleep sandstone) at the head of Smith Creek, near center of sec. 1, T. 24 N., R. 82 W., on the flank of the Shirley Mountains of Carbon County, Wyoming, about 1 mile west of the Nelson Ranch. The holotype of this species was found in the Yeso formation near Alamillo, central New Mexico; and two specimens which we believe to be conspecific were obtained by Alfred G. Fischer from immediately below the "lower phosphate" member of the Phosphoria formation west of Lander, Wyoming, that is, along Spring Creek (=Trout Creek), near the junction of the $SE\frac{1}{4}SW\frac{1}{4}$ sec. 21 and the $NE\frac{1}{4}NW\frac{1}{4}$ sec. 28, T. 1 S., R. 2 W. (Wind River meridian).

Repositories.—State University of Iowa, 2121 (p. 111, figs. 1–6, and 1 unfigured hypotype); University of Wyoming (4 unfigured hypotypes); and University of Wisconsin (pl. 112, figs. 3, 4, and 1 unfigured hypotype).

METACOCERAS BISERIATUM, n. sp.
Plate 113, figure 1

The holotype of this species is a moderately well preserved internal mold representing much of the left lateral half of the living chamber and the adoral one and three-quarters volutions of the phragmacone. Its maximum diameter, measured across the umbilicus is about 125 mm. The preserved part of the living chamber is about one-fourth of a volution in length. The whorls are depressed dorso-ventrally and are considerably wider than high. Near the junction of the phragmacone and the living chamber, where the conch is about 50 mm. high, its width is estimated to be about 65 mm. The ventral and the lateral zones of the conch are strongly flattened and are almost normal to each other. The ventrolateral zone is narrowly rounded. The umbilical shoulder is somewhat more broadly rounded, and the umbilical wall is inclined to the nearly flat lateral zone of the conch at an angle of some 35 degrees. The dorsal zone is distincly concave. The diameter of the umbilicus is equal to almost two-thirds that of the specimen.

Both the umbilical and the ventrolateral shoulders of the holotype bear low rounded nodes, which are somewhat elongate longi-

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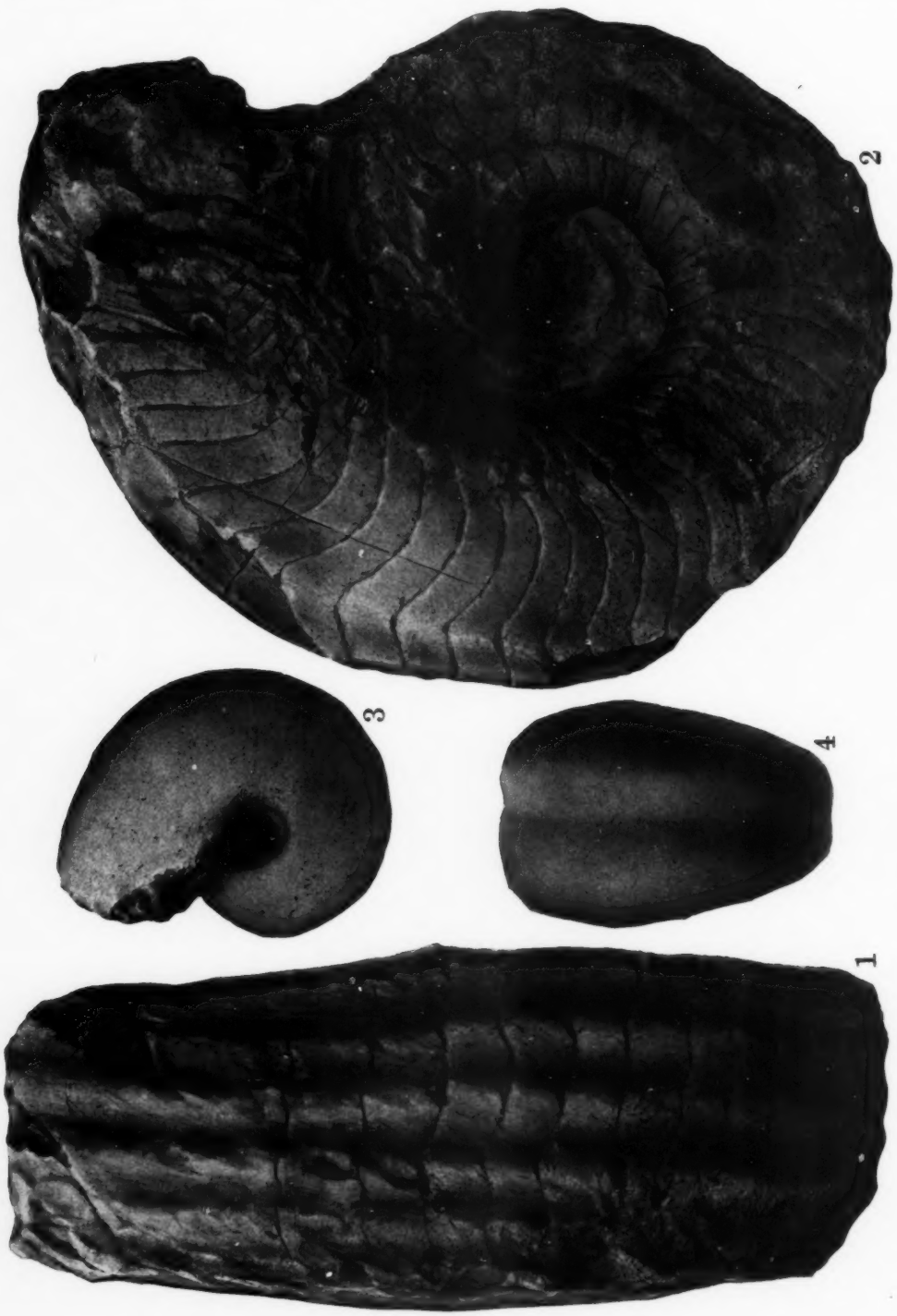
EXPLANATION OF PLATE 111

FIGS. *1–6—Coelogasteroceras mexicanum* (Girty). Two views of each of three specimens from the Minnekahta limestone in the Shirley Mountains of Wyoming. Figures 1–4 are ×1½ whereas 5 and 6 are ×1. (p. 723)

7, 8—Domatoceras northropi, n. sp. Ventral and lateral views of the holotype, from the Chupadera formation near Bluewater Dam, New Mexico, ×1. (p. 735)

Miller and Unklesbay, Permian Nautiloids



Miller and Unklesbay, Permian Nautiloids

tudinally. The spacing of the nodes in each of these rows is fairly regular, but they appear to be independent of each other. The distance between successive nodes and the size of the individual nodes increase progressively orad, and both rows continue undiminished to the adoral end of the specimen. The nodes on the ventrolateral shoulder are somewhat more prominent than are those on the umbilical shoulder.

Each suture forms a broad rather shallow rounded ventral lobe, a very narrowly rounded ventrolateral saddle, a shallow rounded lateral lobe, a rounded saddle on the umbilical shoulder, a very shallow lobe on the umbilical wall, and apparently a dorsal lobe on the impressed zone. The size and position of the siphuncle are not known.

Remarks.—The collections available for study contain a fragmentary septate specimen from the Chupadera formation of New Mexico that we are comparing with this species. It is of about the same size and shape as the phragmacone of the above described holotype and seems to resemble it rather closely, but because of its incompleteness we are uncertain in regard to its specific affinities.

Metacoceras is very abundant in the Pennsylvanian, particularly in the United States and Soviet Russia, but relatively few Permian forms have been described. Nevertheless, Permian representatives of the genus are now known from Soviet Russia, China, Sumatra, and Italy, as well as the United States (Kansas, Nebraska, Arizona, and New Mexico).

As is indicated by the specific name, *M. biseriatum* is characterized particularly by the fact that both its umbilical and its ventro-lateral shoulders bear prominent nodes. *M. angulatum* Sayre of the Middle Pennsylvanian of Missouri also bears two rows of nodes on each side of its conch, but it is a much smaller form.

Occurrence.—Kaibab limestone (α member), along Lake Mary road about 2 miles southwest of Flagstaff, Arizona; and possibly the Chupadera formation near Bluewater Dam, New Mexico.

Repositories.—Museum of Northern Arizona, 563/GZ.1506 (holotype); and University of New Mexico, 318 (specimen compared with this species.)

METACOCERAS? ABERRANS, n. sp.
Plate 113, figure 4; plate 114, figure 4

This species is being based on the figured specimen, but a small incomplete specimen, which may be conspecific, is also available for study. The holotype is only moderately well preserved, and it represents only the right lateral half of the conch. Its maximum diameter, measured across the umbilicus, is about 235 mm. The preserved portion of the living chamber is about one-half of a volution in length.

The whorls are depressed dorsoventrally and are subrectangular in cross section (text fig. 1C). Their ventral and lateral zones and the umbilical walls are almost flat, but the dorsal zone is slightly impressed. Both the umbilical and the ventrolateral shoulders are abrupt and are slightly nodose. The rather poor preservation of the holotype precludes an accurate description of the nodes, but those on the umbilical shoulders seem to be relatively small and to be somewhat longitudinally elongate. Near the midlength of the outer volution of the holotype, the conch is about 65 mm. high and its width (at the umbilical shoulders) is estimated to be about 80 mm. The diameter of the umbilicus is slightly more than half that of the specimen.

The sutures form rather deep broad rounded ventral lobes, high narrowly rounded ventrolateral saddles, relatively shallow lateral lobes, low narrowly rounded dorsolateral saddles, very shallow lobes on the umbilical walls, and presumably shallow saddles on the umbilical seams and a dorsal lobe. The nature and position of the siphuncle are not known.

EXPLANATION OF PLATE 112

FIGS. *1, 2*—*Aulametacoceras mckeei*, n. sp. Two views of the holotype, from the Kaibab limestone about 10 miles south of Flagstaff, Arizona, slightly less than $\times\frac{1}{2}$. (p. 726)

3, 4—*Coelogasteroceras mexicanum* (Girty). Lateral and ventral views of a specimen from the Phosphoria formation west of Lander, Wyoming, $\times 1$. (p. 723)

Remarks.—The small specimen that we are referring with question to this species is about 100 mm. in diameter. It is fragmentary, but it seems to resemble the holotype rather closely but to have somewhat more prominent ventro-lateral nodes.

This species appears to be closely related to *Titanoceras? ingens* Miller, Dunbar, and Condra of the Middle Pennsylvanian of Nebraska and to *Domatoceras militarium* Hyatt and *D. simplex* Hyatt of the Lower Permian of Texas. These four species are almost certainly congeneric. The cross sections of their conchs, particularly their subangular umbilical shoulders, differentiate them readily from typical *Titanoceras* and typical *Domatoceras* (cf. text figs. 1I and 1J). Although in cross section they resemble some representatives of *Metacoceras*, they lack the prominent ventrolateral nodes that are so characteristic of that genus. It therefore seems to us that these four forms represent a distinct genus, but none of them is well enough known to serve satisfactorily as a genotype.

Occurrence.—Both the holotype and the specimen we are referring with question to this species came from the Chupadera formation near Bluewater Dam, New Mexico.

Repository.—University of New Mexico, 315 (holotype) and 318 (specimen referred with question to this species).

Genus AULAMETACOCERAS, n. gen.

Genotype: *Aulametacoceras mckeei*, n. sp.

Conch nautiliconic, and volutions, which are about as high as wide, are flattened ventrally and laterally and slightly impressed dorsally. Ventrolateral and umbilical shoulders abrupt and at least ventrolateral ones are nodose. Umbilicus large. Ventral zone of conch bears several longitudinal grooves and ridges, the latter of which are slightly nodose. Sutures form shallow ventral, lateral, and dorsal lobes. Siphuncle of genotype is not known, but that of a congeneric form is small in size and is located considerably nearer the dorsum than the venter.

This genus resembles *Metacoceras* insofar as general physiognomy, sutures, etc., are concerned, but is readily distinguished by means of the longitudinal grooves and ridges on the ventral zone of its conch. The genotype came from the Middle Permian of Arizona, and the only other species that we are referring to the genus, *Nautilus rectangularis* von Hauer, is from the Upper Triassic of the Carnic Alps. *N. rectangularis* has been referred to both *Trematodiscus* and *Coelonautilus* but it is not closely similar to the type species of either of those genera.

AULAMETACOCERAS MCKEEI, n. sp.
Plate 112, figures 1, 2

Only known representative of this species is a moderately well preserved internal mold, almost all of which is septate. This specimen is somewhat distorted, but its maximum diameter (measured across the umbilicus) is about 280 mm. and the diameter normal to this is about 230 mm. The conch is nautiliconic in its mode of growth. The volutions, which are slightly depressed, are subhexagonal in cross section as they are flattened ventrally, laterally, and dorsolaterally and slightly impressed dorsally, and the ventrolateral and umbilical shoulders are almost subangular (text fig. 1A). Near the mid-length of the outer volution

EXPLANATION OF TEXT FIGURE 1

Cross sections of the fully mature portions of the conch of one species of *Aulametacoceras*, two of *Titanoceras*, two of *Metacoceras?*, one of *Stenopoceras*, and three of *Domatoceras*. **A,** *Aulametacoceras mckeei*, n. sp., based on the holotype at a diameter of about 185 mm., ×¾. **B,** *Titanoceras rotundatum*, n. sp., based on the largest of the syntypes at a diameter of some 150 mm., ×¾. **C,** *Metacoceras? aberrans*, n. sp., based on the holotype at a diameter of about 165 mm. (near the adoral end of the phragmacone), ×¾. **D,** *Titanoceras sanandreasense* Miller, Dunbar, and Condra, based on the specimen represented by text figure 4 at a diameter of about 140 mm., ×¾. **E,** *Stenopoceras cooperi*, n. sp., based on the holotype at a diameter of about 98 mm., ×¾. **F,** *Domatoceras walteri*, n. sp., based on the holotype at a diameter of some 165 mm., ×¾. **G** and **H,** *Domatoceras bradyi*, n. sp., based on the specimen represented by figures 5 and 6 on plate 116 at a diameter of about 115 mm. (G), and on that represented by figure 2 on plate 117 at a diameter of about 150 mm. (H), both ×¾. **I,** *Domatoceras umbilicatum* Hyatt, the genotype of *Domatoceras*, based on the holotype at a diameter of some 115 mm., ×1 (after Hyatt). **J,** *Titanoceras ponderosum* (Meek), the genotype of *Titanoceras*, constructed from Meek's measurements and illustrations of the holotype at a diameter of about 300 mm., ×⅜.

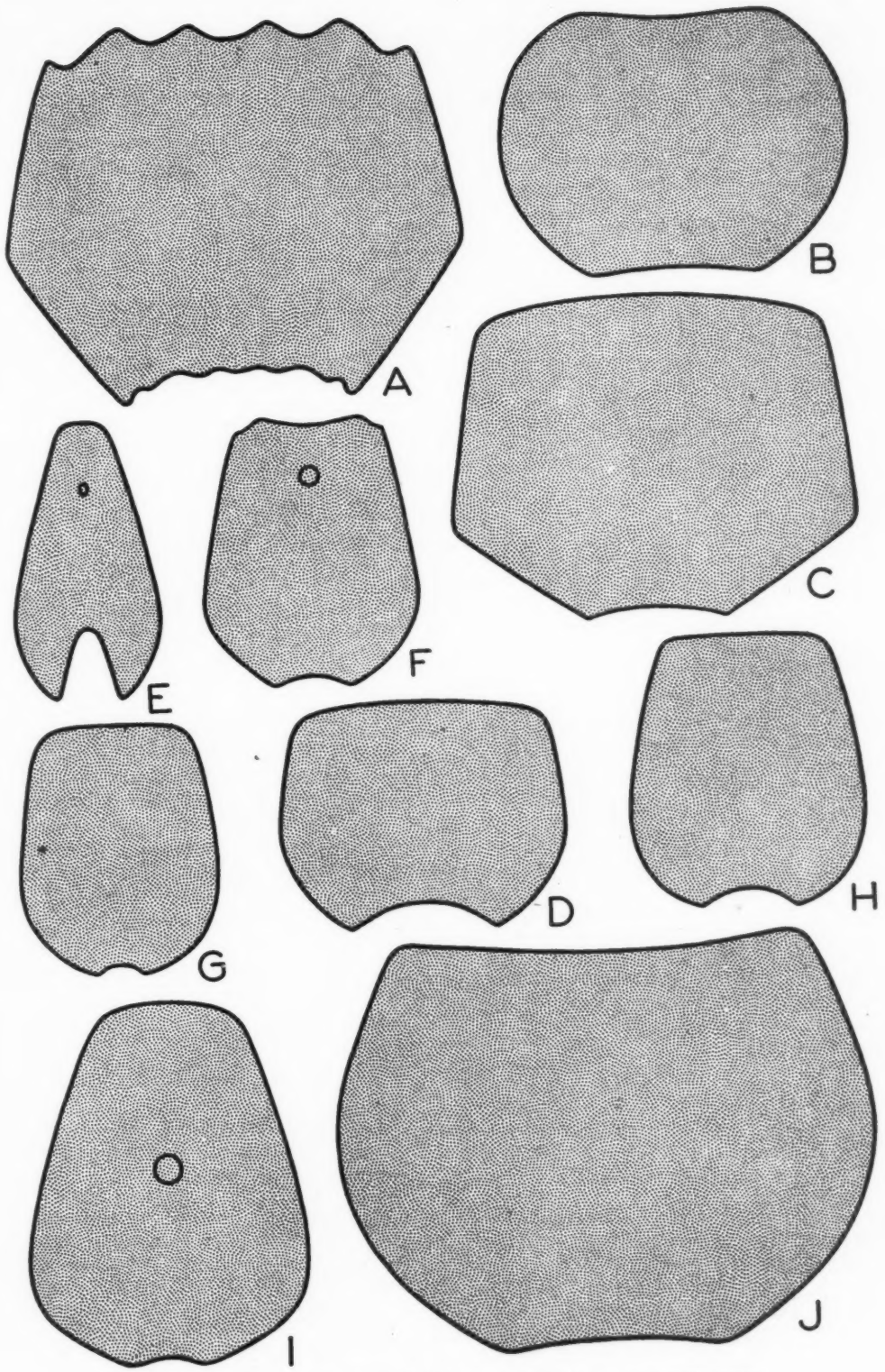


FIG. *1*—Cross sections of nautiloids. For explanation see opposite page.

of the holotype, the conch is some 77 mm. high and 92 mm. wide.

There is a row of low rounded nodes on each umbilical and each ventro-lateral shoulder. Those on the umbilical shoulders are more closely spaced than those on the ventrolateral shoulders. The nearly flat ventral side of the conch bears six prominent ridges and five intermediate grooves. The grooves are more broadly rounded than the ridges, which are slightly but distinctly nodose. The umbilicus is large and its diameter is equal to about one-half that of the conch.

Each suture forms a broad shallow ventral lobe (which is distinctly undulate), narrowly rounded ventrolateral saddles, broad rounded lateral lobes, low narrowly rounded saddles on the umbilical shoulders, very shallow lobes on the umbilical walls, and presumably small saddles on the umbilical seams and a shallow dorsal lobe. Siphuncle unknown, but it is not ventral in position.

Remarks.—The prominent ventral ridges and grooves of this species serve to distinguish it from all other Permian forms known to us. *A. rectangularum* (von Hauer) of the Upper Triassic of the Carnic Alps has a somewhat similar ventral zone, but its umbilical shoulders are not nodose, its ventrolateral nodes are relatively prominent, the cross section of its conch is subquadrate rather than subhexagonal, and its umbilicus is relatively small.

Occurrence.—Kaibab limestone (presumably α member) on east side of Lake Mary, about 10 miles southeast of Flagstaff, Arizona.

Holotype.—Museum of Northern Arizona, 895/G2. 1992.

TAINOCERAS DUTTONI Hyatt
Plate 115, figures 1, 2

Tainoceras duttoni HYATT, *1893*, Texas Geol. Survey Ann. Rept. 4, pp. 401–402, text figs. 3, 4.

The Toroweap formation has yielded a single specimen that seems to be referable to this species. It is an internal mold of the adoral half volution of the phragmacone and the extreme adapical part of the living chamber. The preserved portion of the specimen attains a diameter, measured across the umbilicus, of about 110 mm. In cross section the conch is more or less semicircular, though impressed dorsally, and near its mid-length our specimen is about 40 mm. high and about 70 mm. (estimated) wide. The diameter of the umbilicus is equal to approximately one-half that of the conch. The umbilical walls are very broadly rounded and very steep, being almost parallel to the axis of coiling.

The umbilical shoulders bear longitudinally elongate nodes. Also, on each of the ventrolateral zones of the conch there is a row of large narrowly rounded nodes which are circular or nearly so in cross section; and on each side of the rather deep ventral groove there is a row of large narrowly rounded nodes that are obliquely elongate—the axis of elongation slopes orad from the venter.

The camerae are of only moderate length and those in the adoral portion of the phragmacone of our specimen are particularly short, indicating that we have a fully mature individual. The sutures are of course greatly affected by the rows of nodes and the intermediate longitudinal grooves, but aside from them they form broad shallow rounded lobes on the ventral, lateral, and presumably dorsal zones of the conch as well as on the umbilical walls. As a result of the ornamentation, each suture on our specimen forms a deep narrowly rounded lobe as it crosses a groove and a similar saddle as it crosses a row of nodes. No trace of the siphuncle is visible on this specimen.

Remarks.—In ornamentation, cross section, and general physiognomy, the above-described specimen seems to resemble the

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EXPLANATION OF PLATE 113

FIGS. *1*—*Metacoceras biseriatum*, n. sp. Lateral view of the holotype, from the Kaibab limestone about 2 miles southwest of Flagstaff, Arizona, ×½. (p. 724)

2, 3—*Stenopoceras cooperi*, n. sp., from the Neva limestone near Grand Summit, Kansas, ×¾. (p. 736)

4—*Metacoceras? aberrans*, n. sp. Ventral view of the holotype, from the Chupadera formation near Bluewater Dam, New Mexico, ×½. Same specimen as figure 4 on plate 4. (p. 725)

Miller and Unklesbay, Permian Nautiloids

Miller and Unklesbay, Permian Nautiloids

holotype very closely. Kruglov has described a specimen from the Late Paleozoic of the Ussuri region near Vladivostock that is stated to be very much like *T. duttoni*, but little information is available in regard to this Asiatic form.

Occurrence.—This species was originally based on a single specimen from some unknown horizon (probably the Chupadera formation) in the "upper valley of Zuni Plateau, 12 to 15 miles" southwest of Grants, New Mexico. The specimen described above came from the Toroweap formation (130 feet above the Coconino and the Toroweap contact) about 2 miles south of Coconino Point in Grand Canyon, Arizona.

Repository.—Grand Canyon National Park Museum, Fk-764.

TAINOCERAS MURRAYI, n. sp.
Plate 114, figures 2, 3

Three specimens form the basis for this species, but one of them is much more nearly complete and better preserved than the other two. This holotype, which is septate throughout, is about 65 mm. in diameter. The conch is subrectangular in cross section as it is flattened ventrally and laterally and is slightly impressed dorsally. Near the adoral end of the holotype the conch is about 27 mm. high and about 30 mm. wide. The umbilicus is large and its diameter is equal to about one-half that of the specimen. The umbilical shoulders are fairly distinct but are rounded. The umbilical walls are steep.

The ventrolateral shoulders bear a row of very prominent rounded nodes of which there are about ten in the outer volution of the holotype. There is a rather shallow rounded groove along the venter, and on either side of it is a row of relatively small nodes which are obliquely elongate, with the axis of their elongation sloping orad from the venter. In the adoral half volution of the holotype, there are about fifteen of these nodes in each row. The nodes in the two rows alternate in position, rather than being paired.

The sutures are essentially straight and directly transverse on the umbilical walls, but they form broad shallow rounded ventral, lateral, and presumably dorsal lobes. The details of the suture are, however, affected by the surface ornamentation, and each suture forms a small lobe as it crosses a groove and a similar saddle as it crosses a row of nodes. The nature of the siphuncle in this species is not known.

Remarks.—The two paratypes are relatively poorly preserved and incomplete, and a study of them adds little to a knowledge of the species. They do, however, substantiate the conclusion that the umbilical shoulders in this species are not nodose, and this character seems to differentiate *T. murrayi* from *T. monilifer*, which otherwise it resembles very closely.

Occurrence.—All three of the type specimens were collected by A. N. Murray from a yellow shaly calcareous sandstone about 6.1 feet above the Lecompton limestone (which therefore may be upper Lecompton or basal Tecumseh) near the junction of sec. 32 and sec. 33, T. 28 N., R. 9 E., Osage County, Oklahoma.

Repositories.—State University of Iowa, 2123 (holotype); and University of Tulsa (paratypes).

TAINOCERAS SCHELLBACHI, n. sp.
Plate 114, figure 1; Plate 115, figures 3, 4; Plate 116, figures 1–4.

The holotype of this species is a moderately well preserved silicified internal mold which is septate throughout and which is about 110 mm. in diameter. The cross sec-

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EXPLANATION OF PLATE 114

FIGS. *1*—*Tainoceras* cf. *T. schellbachi*, n. sp. Lateral view of an artificial cast of the inner whorls of the conch, from the Kaibab limestone in the Bottomless Pits about 7 miles east of Flagstaff, Arizona, ×1. (p. 729)

2, 3—*Tainoceras murrayi*, n. sp. Two views of the holotype, from the upper part of the Lecompton limestone (or the basal portion of the Tecumseh shale) in northern Osage County, Oklahoma, ×1. (p. 729)

4—*Metacoceras? aberrans*, n. sp. Lateral view of the holotype, from the Chupadera formation near Bluewater Dam, New Mexico, ×⅔. Same specimen as figure 4 on plate 3. (p. 725)

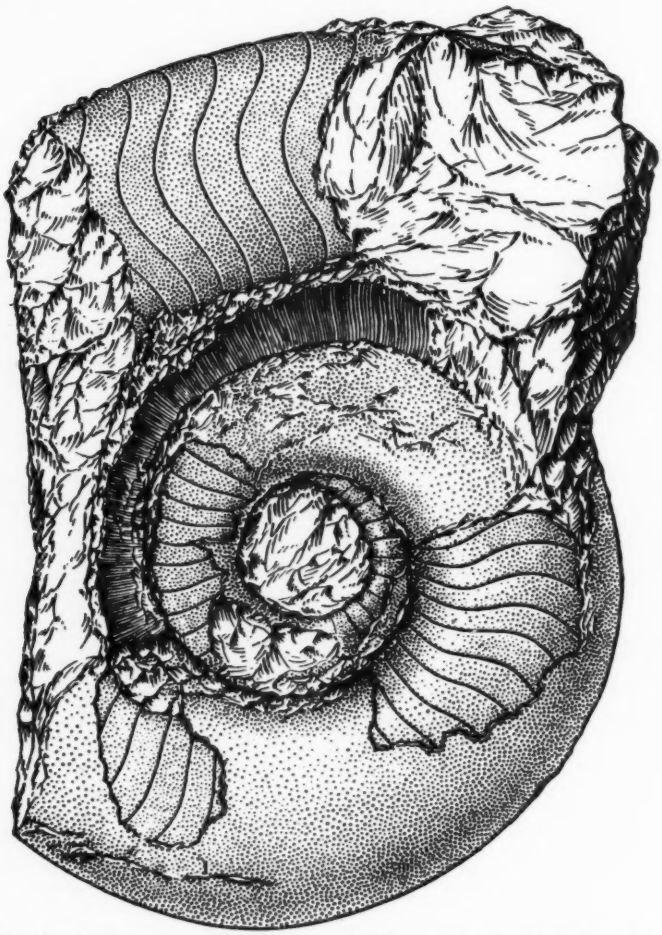


FIG. 2.—Lateral view of a syntype of *Titanoceras rotundatum*. n. sp. from the San Andres limestone of southeastern New Mexico, ×1.

tion is subrectangular as the whorls are depressed dorsoventrally, are flattened ventrally and laterally and slightly impressed dorsally, and the lateral zones are almost parallel. At the adoral end of the holotype the height and width of the conch measure some 45 mm. and 60 mm., respectively, and the impressed zone is some 5 mm. deep. The diameter of the umbilicus is equal to almost two-fifths that of the specimen. The umbilical shoulders are abruptly rounded. The umbilical walls are almost parallel to the axis of coiling and are nearly straight but are slightly convex exteriorly.

Traces of the growth lines are essentially straight and directly transverse on the lateral zones of the conch, but they form a deep V-shaped but narrowly rounded ventral sinus. There is a row of prominent rounded nodes on each umbilical and each ventrolateral shoulder. Those on the umbilical shoulders are smaller and somewhat less numerous than those on the ventrolateral shoulders. There is a deep rounded groove along the venter and on either side of it is a row of nodes that are obliquely elongate, with their axis of elongation sloping orad from the venter. These nodes are also less prominent than the ventrolateral nodes, but they are much more numerous.

The sutures form ventral, lateral, and presumably dorsal lobes. Their shape is of course affected by the nodes, and each suture forms a lobe as it crosses a longitudinal groove and a saddle as it crosses a row of nodes. The siphuncle of the holotype does not appear to be preserved.

Remarks.—The only specimen that we are regarding as a paratype of this species is from the same horizon and locality as the holotype. It is a considerably distorted silicified internal mold which represents only part of one volution of the conch and it is somewhat larger than the adoral portion of the holotype. The specimens represented by figure 1 on plate 114 and by figures 1–4 on plate 116 seem to resemble this species. Their general physiognomy indicates that they probably belong here, but their relationship is somewhat uncertain inasmuch as they represent only the inner whorls of the conch, which are not preserved in the holotype or the paratype.

T. schellbachi differs from *T. duttoni* particularly in that its whorls are more slender. Also, the cross section of the conch in these two species seems to differ markedly, and the ornamentation, though in general similar, is considerably different in detail. The form from the Lower Permian at the Old Military Crossing in Baylor County, Texas, which Hyatt (1893, pp. 402–404) erroneously referred to *Tainoceras quadrangulum* (McChesney), seems to resemble *T. schellbachi* rather closely but its ventrolateral nodes are less prominent and its ventral nodes are more prominent.

The genus *Tainoceras* is now known to range from the Middle Pennsylvanian to the Middle Permian, and to be widespread geographically in the northern hemisphere. That is, representatives of it have been described from the Pennsylvanian of Illinois, Nebraska, Kansas, Texas, and European Russia (Moscow region); and from the Permian of Nebraska, Texas, New Mexico, Arizona, Sicily, northern Italy, Yugoslavia, and Asiatic Russia (Ussuri region near Vladivostok, and possibly Armenia). Typical Pennsylvanian forms, like that represented by figures 2 and 3 on Plate 114, are readily differentiated from the Permian species.

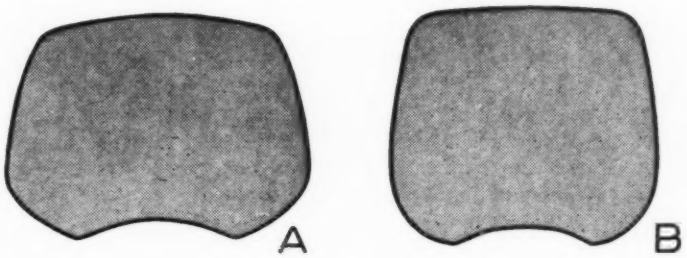


FIG. 3.—Cross sections of early mature portions of the conch of (A) *Titanoceras rotundatum*, n. sp., and (B) *T. sanandreasense* Miller, Dunbar, and Condra, both ×1 and both from the San Andres limestone of southeastern New Mexico. The first is based on the same specimen as text figure 2 at a diameter of about 80 mm.; the second on a topotype in the private collection of H. G. Walter at a diameter of about 78 mm.

Occurrence.—Both the holotype and the paratype came from the Kaibab limestone (β member) at Hilltop, Grand Canyon, Arizona. All three of the specimens being compared with this species also came from the Kaibab of Arizona; one of them (pl. 116, figs. 1, 2) was found near the Iowa State College forestry camp southwest of Flagstaff; the other two came from the α member of the Kaibab in the road-cut at Canyon Padre bridge about 20 miles east of Flagstaff,' (pl. 116, figs. 3, 4) and from the Bottomless Pits about 7 miles east of Flagstaff (pl. 114, fig. 1).

Repositories.—Grand Canyon National Park Museum, Fk-653 (holotype) and Fk-

654 (paratype); Museum of Northern Arizona, 811/G2.1512 (pl. 114, fig. 1) and 570/3060 (pl. 116, figs. 3, 4); and State University of Iowa, 2122 (pl. 116, figs. 1, 2).

TITANOCERAS ROTUNDATUM, n. sp.
Text figures 2 and 3A

(?) . . . McKEE, *1938*, Carnegie Inst. Washington Publ. 492, pl. 18 (unnumbered figure).

Several specimens form the basis for this species. The one represented by text figures 2 and 3A, which consists of two completely septate volutions, is about 130 mm. in diameter. At least the outer whorl of this specimen is depressed dorsoventrally, is flattened ventrally and laterally, and is impressed dorsally. Its lateral zones (which converge ventrad), its ventral zone, and its umbilical walls are all broadly rounded. Both the umbilical and the ventrolateral shoulders are rounded. The maximum width of the conch is attained just ventrad of the umbilical shoulders. Both the umbilicus and the umbilical perforation are large; the diameter of the umbilicus is equal to about half that of the specimen. The test is thick, and near the umbilical shoulders of the adoral portion of the specimen its thickness measures about 3 mm. The growth lines are rather prominent on the exterior of the test. On the adapical half of the inner volution of this specimen there are low inconspicuous lateral nodes. The sutures form broad shallow rounded ventral, lateral, and presumably dorsal lobes, and rather narrowly rounded saddles on the ventrolateral and umbilical shoulders—they are essentially straight on the umbilical walls.

No trace of the siphuncle is visible in this specimen. However, in one of the fragmentary syntypes from the same horizon and locality the siphuncle is moderately large and is subcentral in position but is slightly nearer the dorsum than the venter. Its diameter is about 3.7 mm. where the conch is about 42 mm. high and about 55 mm. wide.

The specimen on which text figure 1B is based represents the adapical third of a volution of the living chamber and the inner one and one-half volutions of the phragmacone. The maximum diameter of the preserved portion of the conch of this specimen is estimated to have been about 160 mm. The inner volutions of this specimen seem to resemble very closely equal-sized portions of the septate specimen represented by text figure 2. The outer volution, however, differs in cross section from the inner volutions; it is broadly rounded laterally, ventrolaterally, and dorsolaterally, and is slightly concave both dorsally and ventrally. However, the sutures on this outer volution are essentially the same as on the preceding one.

Remarks.—The Kaibab specimen figured by McKee in 1938 seems to resemble this form but to be somewhat more closely coiled and to have a smaller umbilical perforation. Nevertheless, we are doubtfully placing it in this species and are associating with it several less nearly complete specimens from the same formation. The collections of the Museum of Northern Arizona contain a specimen (no. 1063/G2. 1299) from a road-cut at the Canyon Padre bridge which resembles McKee's figured specimen very closely, and these two may represent a distinct species.

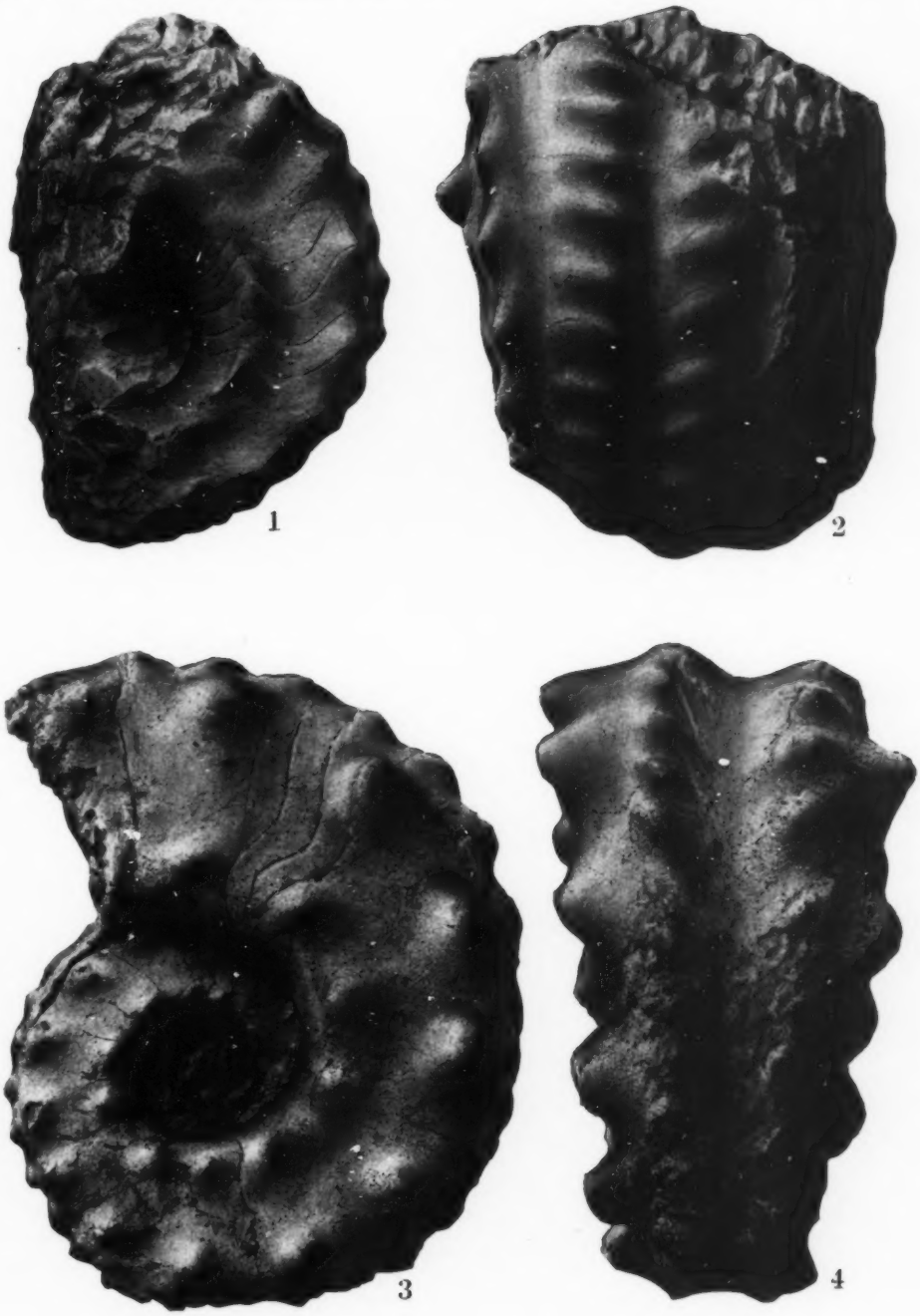
This species differs from *T. sanandreasense* Miller, Dunbar, and Condra, with which it occurs in association, in that its whorls are relatively broader and lower. Also, the lateral and particularly the ventrolateral zones of its conch are much rounder at full maturity.

Occurrence.—All five of the syntypes came from the San Andres limestone (150–200 feet below the top) on the west side of the Penasco River Valley about 52 miles west of Artesia on the highway to Cloudcroft, New Mexico. Several specimens that we are referring to the species with question came from the Kaibab limestone (α member) at the following localities in Arizona: (1)

EXPLANATION OF PLATE 115

FIGS. *1, 2—Tainoceras duttoni* Hyatt. Two views of a well preserved internal mold from the Toroweap formation south of Coconino Point in Grand Canyon, Arizona, ×⅔. (p. 728)

3, 4—Tainoceras schellbachi, n. sp., The holotype, from the Kaibab limestone near Hilltop, Grand Canyon, Arizona, ×⅔. (p. 729)



Miller and Unklesbay, Permian Nautiloids

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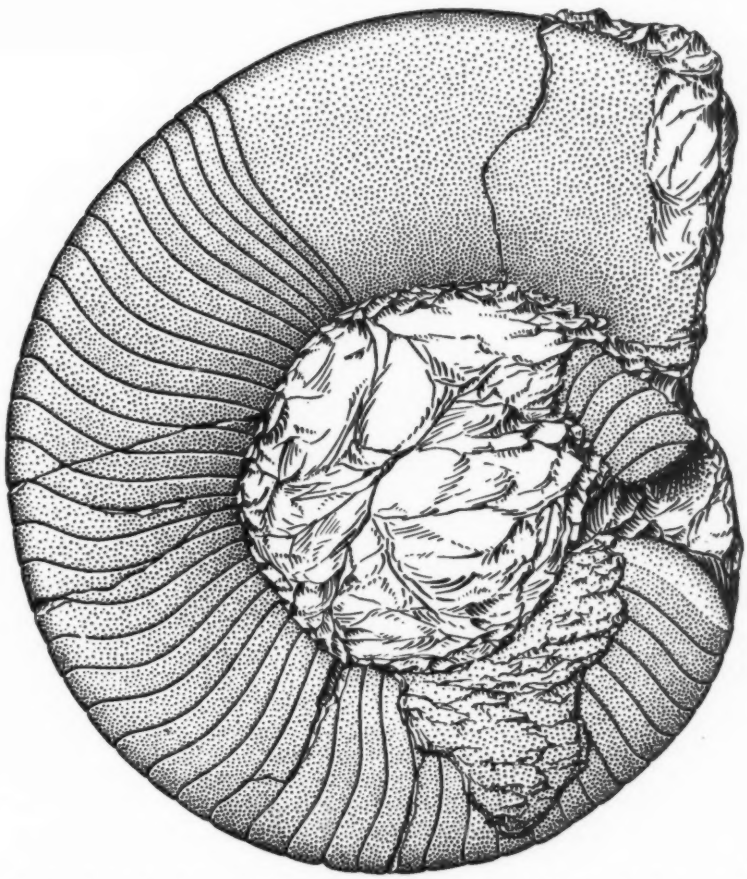

FIG. 4.—Lateral view of *Titanoceras sanandreasense* Miller, Dunbar, and Condra?, from the Kaibab limestone (α member) near the Canyon Padre bridge, about 20 miles east of Flagstaff, Arizona. Same specimen as text figure 1D.

Grand Canyon Village (4 specimens including the one figured by McKee in 1938), (2) Grandeur Point in Grand Canyon (2 specimens), (3) Bottomless Pits about 7 miles east of Flagstaff (1 specimen), and (4) road cut at Canyon Padre bridge about 20 miles east of Flagstaff.

Repositories.—Texas Technological College (all 5 syntypes); Museum of Northern Arizona (two questionable representatives of species numbered 811/G.598 and 1063/G2. 1299); and Grand Canyon National Park Museum (3 questionable representatives of species numbered Fk-236, 1 numbered Fk-237, and 2 numbered Fk-287).

TITANOCERAS SANDREASENSE Miller, Dunbar, and Condra
Text figures, 1D, 3B, and 4

Titanoceras sanandreasense MILLER, DUNBAR, and CONDRA, *1933*, Nebraska Geol. Survey Bull. 9, 2d ser., pp. 204–206, pl. 13, fig. 7; pl. 17, figs. 1, 2.

We have available for study a topotype of this species which seems to resemble the holotype very closely but is essentially free from distortion. The shape of the early mature portion of the conch of this specimen is elucidated by text figure 3B.

The collections of Kaibab nautiloids that have been loaned to us for study contain

six specimens that do not seem to differ materially in any available particular from our topotype. However, five of them are only fragments of the internal mold of the chambered portion of the conch, and the sixth (text figures 1D and 4) does not retain the inner volutions. Therefore we are somewhat uncertain in regard to their affinities and we are referring them to this species with question. The best of our Kaibab specimens attains a maximum diameter, measured across the umbilicus, of about 170 mm. The adoral camerae of this specimen are relatively short, indicating that it represents a fully mature individual. The portion of the living chamber that is preserved is only about one-fourth of a volution in length. The cross section of the conch is represented by text figure 1D.

Occurrence.—This species was originally described from the San Andres limestone (about 150–200 feet below the top) on the west side of the Penasco River Valley about 52 miles west of Artesia on the highway to Cloudcroft, New Mexico; and we have an additional specimen from the same horizon and locality. Also, we are referring to this species with question six specimens from the Kaibab limestone (α member) of Arizona; four of these came from Grand Canyon Village, one is from Grandeur Point in Grand Canyon, and the sixth from the Canyon Padre bridge which is about 20 miles east of Flagstaff.

Repositories.—Museum of Northern Arizona, 1033/G2.1109 (text figs. 1D and 4); private collection of H. G. Walter of Findlay, Ohio (text fig. 3B); and Grand Canyon National Park Museum, Fk-8, Fk-236A, Fk-236B, Fk-287A, and Fk-515.

DOMATOCERAS BRADYI, n. sp.
Plate 116, figures 5, 6; Plate 117, figure 2; text figures 1G and 1H

The holotype of this species, is a fairly complete internal mold, well preserved in very fossiliferous pink dolomite. Its maximum diameter, measured across the umbilicus, is about 155 mm. The adoral 50 mm. of this specimen represent the living chamber, which is not complete. The inner volutions of the conch are not preserved.

The whorls are considerably higher than wide, and their lateral and ventral sides are essentially flat. The ventrolateral zones are very narrowly rounded, whereas the dorsolateral ones are broadly rounded. The dorsal side appears to be slightly concave, that is, to be somewhat impressed by the preceding volution. In cross section the whorls are subrectangular (text fig. 1G) as the lateral zones are almost parallel (though they converge slightly ventrad) and are almost perpendicular to the ventral side. The maximum width of the holotype, which is attained at the rather indefinite umbilical shoulders, measures about 52 mm.; the corresponding height of conch is about 56 mm. The diameter of the umbilicus is approximately one-half that of the specimen.

There is a prominent raised line along the venter of the holotype, but otherwise there is no ornamentation. The sutures form broad shallow ventral and lateral (and almost certainly dorsal) lobes, similar dorsolateral saddles, and relatively narrow ventrolateral saddles.

Remarks.—The collections that we are studying contain five specimens that seem to be conspecific with the holotype, and can therefore be regarded as paratypes. The best of these (pl. 117, fig. 2) is somewhat larger than the holotype, the cross section of its conch differs slightly (cf. text figs. 1G and 1H), and there are inconspicuous lateral nodes on its penultimate volution. The maximum diameter attained by the phragmacone of this specimen measures about 170 mm. (estimated). In another of the paratypes (Museum of Northern Arizona, 698/G2.1371), which is about 175 mm. in diameter, the preserved portion of the living chamber is at least one-fourth of a volution in length.

Representatives of *Domatoceras* are now known to be widespread in the northern hemisphere and to range in age from Lower Pennsylvanian to Upper Permian. They are fairly abundant in the Pennsylvanian of both the United States and Soviet Russia and occur also in the Permian of these two countries as well as India and Timor. Superficially, at least, the species under consideration is perhaps closest to *D. mosquense* (Tzwetaev) of the Lower Pennsylvanian of central European Russia and to *D. williamsi* Miller and Owen of the Lower Pennsylvanian of Missouri. However, in both of these

forms, as in the genotype (text fig. 1I), the whorls are relatively high and narrow in comparison with those of *D. bradyi*. None of the forms heretofore described from the Permian is very similar to our species. The specific name is given in honor of L. F. Brady who loaned us the holotype and the paratype which retains much of the living chamber.

Occurrence.—The holotype came from the Kaibab limestone (α member) at the Bottomless Pits, about 7 miles east of Flagstaff, Arizona. Two of the paratypes are from the same horizon (1) on the east side of Lake Mary (about 10 miles southeast of Flagstaff) and (2) near Grandeur Point in Grand Canyon. A third paratype was found near High Rolls, New Mexico; and the other two were collected from the San Andres limestone (about 150–200 feet below the top) on the west side of the Penasco River Valley about 52 miles west of Artesia on the highway to Cloudcroft, New Mexico.

Types.—Museum of Northern Arizona, 811/G2.1517 (holotype) and 698/G2.1371 (unfigured paratype); Grand Canyon National Park Museum, Fk-287B (Grandeur Point specimen) and Fk-735 (unfigured paratype from High Rolls); Texas Technological College (unfigured paratype from Penasco River Valley); and private collection of H. G. Walter of Findlay, Ohio, (pl. 117, fig. 2).

DOMATOCERAS NORTHROPI, n. sp.
Plate 111, figures 7, 8

Two representatives of this species are available for study. The holotype (pl. 111, figs. 7, 8) represents most of the phragmacone and the adapical portion of the living chamber, whereas the paratype represents most of the living chamber and the adoral portion of the phragmacone. The diameter of the holotype, measured across the umbilicus, is about 110 mm. The whorls are almost flat ventrally and laterally, are narrowly rounded ventrolaterally and more broadly rounded dorsolaterally, and are slightly impressed dorsally. The flattened lateral zones are almost parallel but converge slightly ventrad. Near the midlength of the outer volution of the holotype, the conch is about 26.5 mm. high and its maximum width, which is attained at the rounded umbilical shoulders, is about 25.5 mm. The diameter of the umbilicus is equal to almost half that of the specimen. The paratype shows that the living chamber is at least one-third of a volution in length, and that it attains a maximum width of at least 62 mm.

The ventrolateral zones of the conch bear low rounded nodes of which there are three in the adoral half volution of the holotype. Such nodes are present on even the adoral portion of the living chamber of the paratype, and there appear to be about four of them on each ventrolateral zone of the adoral half volution of that specimen.

The sutures form very shallow broad rounded ventral, lateral, and dorsal lobes, and similar but somewhat narrower ventrolateral and dorsolateral saddles. The siphuncle is small and is located considerably ventrad of the center of the conch. Near the midlength of the outer volution of the holotype, where the conch is about 26.5 mm. high, the siphuncle is about 2.5 mm. in diameter and is about 6.5 mm. from the venter.

Remarks.—The most distinctive feature of this species is the more or less square cross section of its conch. Also, the ventrolateral nodes help to differentiate it from similar congeneric forms. The specific name is given in honor of Stuart A. Northrop, who loaned us the type specimens.

Occurrence.—Chupadera formation near Bluewater Dam, New Mexico.

Types.—University of New Mexico, 316 (holotype) and 317 (paratype).

DOMATOCERAS WALTERI, n. sp.
Plate 117, figure 1; text figure 1F

The holotype of this species is a moderately well preserved internal mold which is septate throughout. We estimate that the preserved part of this specimen attained a diameter of at least 165 mm. The adapical portions of the holotype are not well preserved, but the outer whorl is compressed laterally and is subrectangular in cross section (text fig. 1F). Its ventral side is slightly but distinctly concave, its lateral zones are almost flat and are slightly convergent ventrally, and its dorsal side is somewhat impressed. The dorsolateral zones (the umbilical shoulders) are broadly rounded, whereas the ventrolateral zones are grooved.

In the penultimate volution of the holotype the cross section is similar but the ventrolateral zones are abruptly rounded rather than grooved. At the adoral end of the penultimate volution, the conch is about 35 mm. high and its maximum width, which is attained at the indefinite umbilical shoulders, is about 25 mm. Corresponding measurements at the adoral end of the specimen are about 66 mm. and 47 mm., respectively. The diameter of the umbilicus is equal to about half that of the specimen.

On at least the left lateral zone of the preserved portion of the penultimate volution of the holotype, there are two prominent rounded nodes which are longitudinally elongate and are about one-third of a volution apart. These nodes are located slightly ventrad of the mid-height of the whorl.

The sutures form broad shallow rounded ventral, lateral, and presumably dorsal lobes, similar dorsolateral saddles, and narrower ventrolateral saddles which are flattened medianly in the adoral volution where the sutures cross the ventrolateral grooves. The siphuncle is small and is located approximately mid-way between the center and the venter. Where the conch is about 56 mm. high and about 43 mm. wide, the siphuncle is about 4.5 mm. in diameter and is about 8 mm. from the venter.

Remarks.—By far the most distinctive features of this species are the lateral nodes and the ventrolateral grooves of its conch. Insofar as we have been able to ascertain, both of these are unique for the genus. The available collections contain a fragmentary specimen that we are referring to this species with question. It is of about the same size and shape as the penultimate volution of the holotype and, like it, bears lateral nodes.

Occurrence.—Both the holotype and the fragmentary specimen we are associating with it were obtained by H. G. Walter, in whose honor the species is named, from the San Andres limestone (about 150–200 feet below the top) on the west side of the Pecos River Valley about 52 miles west of Artesia on the highway to Cloudcroft, New Mexico.

Repository.—Texas Technological College.

STENOPOCERAS COOPERI, n. sp.
Plate 113, figures 2. 3

The holotype is a well preserved internal mold which is septate throughout. Its maximum diameter measures about 98 mm. At least the outer whorl is flattened (but nevertheless is distinctly convex) laterally and ventrally, subangular ventrolaterally, and impressed dorsally (text fig. 1E). The maximum width of the conch is attained somewhat dorsad of the mid-height of the whorl. At the adoral end of the holotype the conch attains a maximum width of about 28 mm., the whorl is about 57 mm. high, and the impressed zone is about 20 mm. deep. The umbilicus is inconspicuous, and the umbilical shoulders are broadly rounded and indefinite. On the internal mold the umbilicus is not closed, and the umbilical perforation in the outer volution of the holotype is about 7 mm. in diameter. At maturity the test may, of course, have been thick enough in the umbilical region to close this perforation.

The sutures form a high blunt ventral saddle, broad deep rounded lateral lobes, high rather narrowly rounded saddles centering just inside the umbilical shoulders, and apparently lobes centering on the umbilical seams. The siphuncle is small, is elliptical in cross section (as compressed laterally), and is subventral in position. At the adoral end of the holotype, the siphuncle is about 1.5 mm. wide and about 2 mm. high, and it is located about 6 mm. from the venter.

Remarks.—Only a few representatives of *Stenopoceras* have been mentioned in the literature. These came from the Fort Riley limestone and the Florena shale (both Lower

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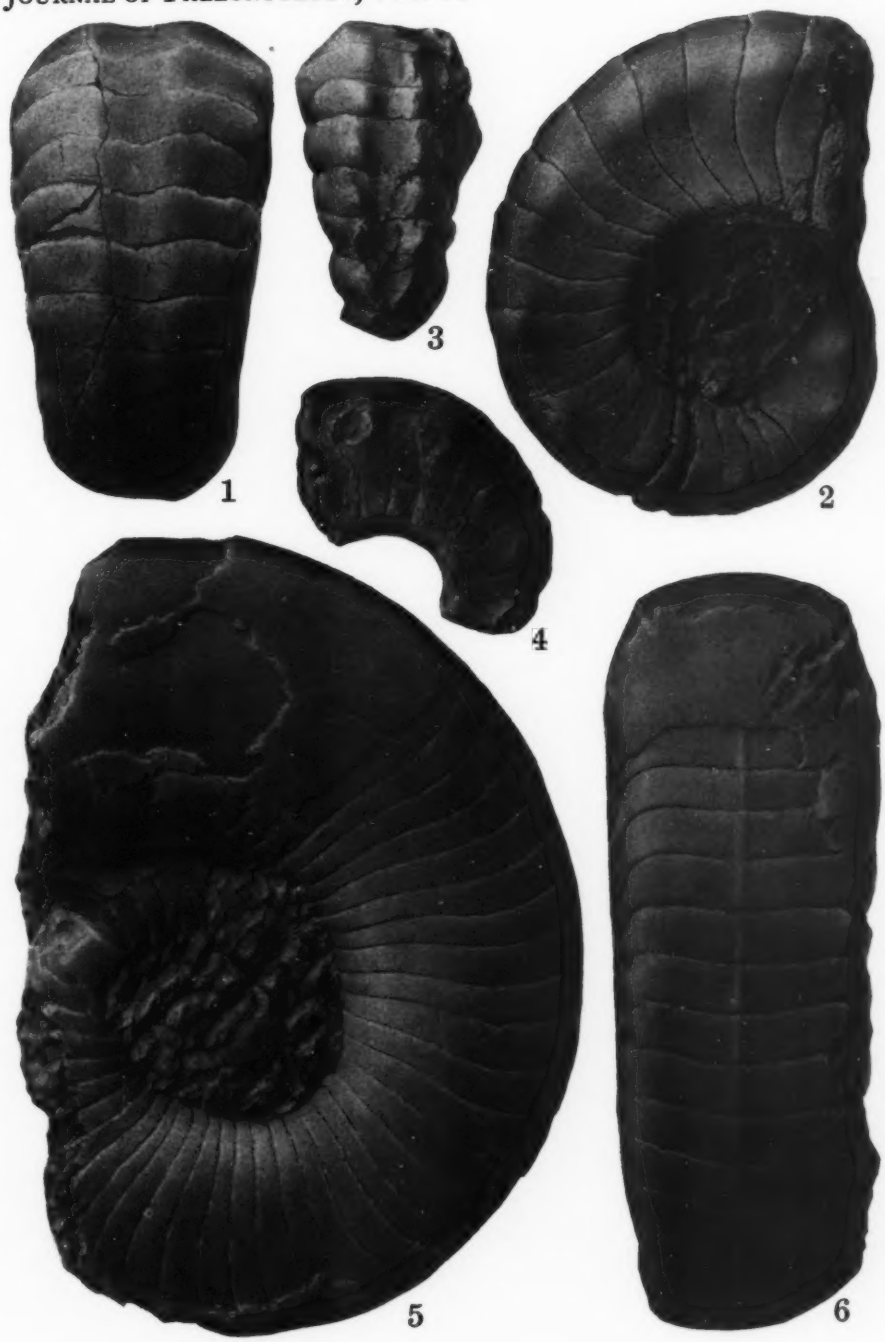
EXPLANATION OF PLATE 116

FIGS. *1–4*—*Tainoceras* cf. *T. schellbachi*, n. sp. Two specimens from the Kaibab limestone in the general vicinity of Flagstaff, Arizona, ×1. (p. 729)

5, 6—*Domatoceras bradyi*, n. sp. Two views of the holotype, from the Kaibab limestone east of Flagstaff, Arizona, ×⅔. (p. 734)



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Permian) of Kansas, some unrecorded horizon and locality in Texas, the Pennsylvanian of Nebraska, the Upper Pennsylvanian of New Mexico, the Casper sandstone (Upper Pennsylvanian) of Wyoming, and the Upper Carboniferous of central European Russia. The specimen known from the Florena shale has never been illustrated or described, and that from the Fort Riley has a much narrower ventral zone than our form. *S. cooperi* seems to resemble closely only *S. tularosense* Miller of the Upper Pennsylvanian of New Mexico, but unfortunately the mature portions of the phragmacone of that species are very poorly known. *Stenopoceras? orientalis* Chao of the Lower Carboniferous of China does not belong in this genus.

Occurrence.—The above-described specimen was found by B. N. Cooper in the upper shaly beds of the Neva limestone (upper Grenola limestone) near the Cowley-Elk county-line along U. S. Highway 160 close to Grand Summit, Kansas.

Holotype.—State University of Iowa, 2120.

ADDENDUM

Since this manuscript was completed, C. E. Needham has sent us a fragment of a fairly large *Domatoceras* from a limestone in the midportion of the Yeso formation (about 725 feet below the top) in the Sacramento Mountains near Bent, New Mexico. Also, S. A. Northrop has loaned us for study the following forms from the Chupadera (probably San Andreas equivalent) of New Mexico: (1) *Domatoceras northropi* from the eastern slope of the Sacramentos near Elk; (2) *Titanoceras rotundatum* from near Bluewater Dam; and (3) *T.* sp., *Domatoceras bradyi?*, and *D.* sp. from the Cerrito Tularosa west of Tularosa.

REFERENCES

ABICH, HERMANN, *1878*, Eine Bergkalkfauna aus der Araxesenge bei Djoulfa in Armenien: *Geol. Forschungen in Kaukasischen Ländern*, Theil 1, pp. 1–128, pls. 1–11.

DARTON, N. H., *1925*, A résumé of Arizona geology: *Arizona Univ., Arizona Bur. Mines Bull.* 119, pp. 1–298, pls. 1–74.

DIENER, CARL, *1903*, Permian fossils of the Central Himalayas: *India Geol. Survey Mem., Pal. Indica*, ser. 15, vol. 1, pt. 5, pp. 1–204, pls. 1–9.

——, *1897*, Über ein Vorkommen von Ammoniten und Orthoceran im südtirolischen Bellerophonkalk: *Kais. Akad. Wissen. Sitzungsber., math.-naturwissen. Classe*, Bd. 106, Abt. 1, pp. 61–76, 1 pl.

FLIEGEL, G., *1901*, Über Obercarbonische Faunen aus Ost- und Südasien: *Palaeontographica*, Bd. 48, pp. 91–136, pls. 6–8.

GEMMELLARO, G. G., *1890*, La fauna dei calcari con Fusulina della valle del fiume Sosio nella provinca di Palermo: *Giorn. Sci. Nat. ed. Econ.*, vol. 20, pp. 97–112, pls. 11, 12, 16–18.

GIRTY, G. H., *1908*, The Guadalupian fauna: *U. S. Geol. Survey Prof. Paper* 58, pp. 1–651, pls. 1–31.

——, *1909*, Paleontology of the Manzano group [of the Rio Grande valley, New Mexico]: *U. S. Geol. Survey Bull.* 389, pp. 41–136, pls. 6–12.

GRABAU, A. W., *1923–24*, Stratigraphy of China, Part 1, Palaeozoic and older: *China Geol. Survey*, pp, 1–528, pls. 1–6. [Pages 1–200 were issued in 1923 and 201–528 in 1924].

GRECO, BENEDETTO, *1935*, La fauna permiana del Sosio conservata nei Musei di Pisa, di Firenze e di Padova, Parte Prima, Introduzione—Considerazioni geo-paleontologiche, Tunicata(?), Crustacea, Cephalopoda. *Paleontographica Italica*, vol. 35, pp. 101–190, pls. 12–15.

HANIEL, C. A., *1915*, Die Cephalopoden der Dyas von Timor: *Paläontologie von Timor*, Lief. 3, Abh. 6, pp. 1–153, pls. 46(1)–56(11).

HAY, ROBERT, *1893*, Notes on some new species of fossil cephalopods: *Kansas Acad. Sci. Trans.*, vol. 13, pp. 37–47.

HYATT, ALPHEUS, *1891*, Carboniferous cephalopods: *Texas Geol. Survey Ann. Rept.* 2, pp. 327–356.

——, *1893*, Carboniferous cephalopods; Second paper: *Texas Geol. Survey Ann. Rept.* 4, pp. 377-474.

JAKOWLEW, N., *1899*, Die Fauna einiger oberpalaeozoischer Ablagerungen Russlands; I, Die Cephalopoden und Gastropoden: *Mém. Com. géol.*, vol. 15, no. 3, pp. 1–140, pls. 1–5.

KAYSER, EMANUEL, *1883*, Obercarbonische Fauna von Lo-ping: Richtohofen's *China*, Bd. 4, pp. 160–208, pls. 19–29.

KRUGLOV, M. V., *1928*, Upper Carboniferous and Artinskian *Nautilidae* of the Ural: *Travaux Musée Géol., Acad. Sci.* URSS, Tome 3, pp. 63–206, pls. 5–15.

EXPLANATION OF PLATE 117

FIGS. *1—Domatoceras walteri*, n. sp. Lateral view of the holotype, from the San Andres limestone about 52 miles west of Artesia, New Mexico, ×1. (p. 735)

2—Domatoceras bradyi, n. sp. Lateral view of a paratype, from the same horizon and locality as the preceding, ×½. (p. 734)

——, *1930*, Nautiloïdea aus dem Ober-Paläozoicum vom Ussuri-Gebiet: *Mém. Soc. Russe de Minéral*, 2d ser., vol. 59, pp. 113–117.

——, *1933*, The Upper Permian *Nautilidae* of the Pinega and Kuloi rivers basins: *Acad. Sci. U.S.S.R., Trans. Geol. Inst.*, tome 3, pp. 185–208, pls. 1–3.

LICHAREW, BORIS, *1926*, Restes des Nautiloidea dans les dépôts du Permien supérieur du bassin de la rivière Waga: *Com. géol. Leningrad Bull.*, vol. 41, pp. 53–68, pls. 8, 9.

——, *1939*, Division Nautiloidea, Nautiloids: *Central Geol. and Prospecting Inst. Atlas of leading forms of fossil fauna USSR, vol. VI, Permian*, pp. 154–160, pls. 38–40.

MCKEE, E. D., *1938*, The environment and history of the Toroweap and Kaibab formations of northern Arizona and southern Utah: *Carnegie Inst. of Washington Publ.*, no. 492, pp. 1–268, pls. 1–48.

MEEK, F. B., and HAYDEN, F. V., *1865*, Paleontology of the Upper Missouri; Invertebrates: *Smithsonian Contr. Knowledge*, vol. 14, art. 5 (172), pp. 1–136.

MERLA, GIOVANNI, *1930*, La Fauna del Calcare a Bellerophon della Regione Dolomitica: *R. Univ. Padova Mem. Inst. Geol.*, vol. 9, no. 2, pp. 1–221, pls. 1–11.

MILLER, A. K., and CLINE, L. M., *1934*, Cephalopods of the Phosphoria formation of northwestern United States: *Jour. Paleontology*, vol. 8, pp. 281–302, pl. 39.

MILLER, A. K., and CROCKFORD, M. B. *1936*, Permian cephalopods from British Columbia: *Royal Soc. Canada Trans.*, 3d ser., sec. IV, vol. 30, pp. 23–28, pl. 1.

MILLER, A. K., DUNBAR, C. O., and CONDRA, G. E., *1933*, The nautiloid cephalopods of the Pennsylvanian system in the Mid-Continent region: *Nebraska Geol. Survey Bull.* 9, 2d ser., pp. 1–240, pls. 1–24.

MILLER, A. K., and FURNISH, W. M., *1940*, Permian ammonoids of the Guadalupe Mountain region and adjacent areas: *Geol. Soc. Am. Spec. Paper*, no. 26, pp. 1–242, pls. 1–44.

MILLER, A. K., and THOMAS, H. D., *1936*, The Casper formation (Pennsylvanian) of Wyoming and its cephalopod fauna: *Jour. Paleontology*, vol. 10, pp. 715–738, pls. 96–99.

SHUMARD, B. F., *1859*, Notice of fossils from Permian strata of Texas and New Mexico . . . ; *St. Louis Acad. Sci. Trans.*, vol. 1, pp. 387–403, pl. 11.

STOYANOW, A. A., *1909*, On the character of the boundary of Palaeozoic and Mesozoic near Djulfa: *Russ.-kais. min. Gesell. St. Petersburg Verh.*, Bd. 47, ser. 2, pp. 61–135, pls. 6–9.

SUESS, EDUARD, *1894*, Beiträge zur Stratigraphie Central-Asiens auf Grund der Aufsammlungen von F. Stoliczka und K. Bogdanowitsch . . . : *Kais. Akad. Wissen. Denkschr., math.-naturwissen, Classe*, Bd. 61, pp. 431–466, 1 pl.

SWALLOW, G. C., and HAWN, FREDERICK, *1858*, The rocks of Kansas: *St. Louis Acad. Sci. Trans.*, vol. 1, pp. 173–197.

WAAGEN, WILLIAM, *1879*, Salt-Range fossils; *Productus* limestone fossils: *India Geol. Survey Mem., Pal. Indica*, ser. 13, vol. 1, pt. 1, pp. 1–72, pls. 1–6.

WHITE, C. A., *1891*, The Texas Permian and its Mesozoic types of fossils: *U. S. Geol. Survey Bull.* 77, pp. 1–51, pls. 1–4.

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MISSOURIAN TRITICITES OF THE NORTHERN MID-CONTINENT

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ABSTRACT.—The tendency toward fine discrimination in fusulinid species has made necessary standardization in their study. Theories and practices of fusulinid study are herein discussed in some detail. Four new species of *Triticites* are described from the Missouri series of the Pennsylvanian system; one species from the Virgil series and two from the Missouri are redescribed, and the characters of the other five known Missourian species from the northern mid-Continent are shown in graphs; thus bringing together the known Missourian species. Finally consideration is given to the ontogeny and phylogeny of the group.

INTRODUCTION

THIS PAPER is in part an outgrowth of the writer's difficulties in using published descriptions of fusulinid species. While the usual descriptions may be adequate for a fusulinid expert, the ordinary paleontologist finds them well nigh impossible to use since they do not tell him enough about a particular species. In presenting the material below, the writer has been guided by the needs of the general stratigraphic paleontologist. The fusulinid expert with extensive collections at hand for comparison may not find this material to be more useful than more orthodox descriptions, but it is hoped that he will find it more complete.

The writer wishes to acknowledge his indebtedness to Dr. Norman D. Newell whose constant interest and helpful suggestions have left an impress on this paper. Several of the collections studied were furnished by the Kansas Geological Survey.

THE STATISTICAL METHOD

It is almost a truism that the individuals of a species differ from one another, yet it is surprising how many paleontologists have ignored this obvious fact. No one has ever said that the species *Homo sapiens* is made up of individuals that are exactly six feet tall, brown eyed, blonde haired and brachycephalic. Everyone will agree that some are five feet tall, blue eyed, red haired and dolicephalic. Yet species after species have been described under the assumption that they show almost no individual variation. The consequence is that a great part of the literature is crowded with descriptions which are difficult or impossible to use when one seeks to identify unknown specimens.

Obviously, if species admit variation, then an adequate description must involve a consideration of the extent of the variation. Usually this is done in an informal sort of way by looking at a number of specimens and noting that the characters vary from thus to so. The statistical method is simply a formal method of doing the same thing. A number of specimens are studied and the extent of the variation *carefully recorded*. It is to make sure that the recorded facts are significant that the simple techniques of the statistical method are used. There are some who favor description of the normal individual, apparently believing that the extremes of variation are of little significance. Let us apply this to fusulinids. The describer publishes the variation which may occur in the characters of a normal individual. By the usual definition, a normal individual is one which, as far as any particular character is concerned, occupies a position within the central half of a population. He does this for eight characters which are readily measurable. The question then arises as to what proportion of the individuals in a population will be normal in all characters. One half of them? No, according to the theory of probability less than one specimen in 250. If ten characters were described, the proportion would be less than one in 1,000. Obviously, the range in variation must be determined as completely as possible.

For a detailed treatment of statistical methods, the reader is referred to the recently published "Quantitative Zoology" by Simpson and Roe. In the subsequent discussion the application of these methods to fusulinids is considered.

THE STATISTICAL METHOD APPLIED TO FUSULINIDS

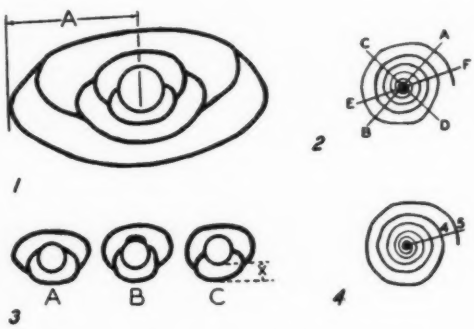
Number of specimens studies.—The individuals of a species differ from one another, therefore it is necessary to study a number of specimens to determine the extent in which they differ. The minimum number needed for this objective can not be foretold for any particular group. By simple trial and error, it was found that 10 or 12 slides each of axial and saggital sections would give an adequate idea as to the variation in fusulinids. In some cases, as many as 20 or more were studied, and in one case, only three saggital sections were available. In the latter case, however, usable results were obtained by means of a method explained in the section below dealing with graphic presentation of data. The above, however, refers only to the original study of the species. Usually two or three specimens will serve to identify a species after it has been adequately described on a statistical basis.

Preparation of thin-section.—Care must be taken in the preparation of the thin-sections. The axis of coiling must be parallel to the slide in the axial sections and perpendicular to the slide in the saggital sections. In both cases the proloculum must be accurately centered. Measurements taken in other slides are of limited usefulness. The diameter of the proloculum is a valuable character in differentiating Missourian species but it can not be used unless the sections used are well centered.

Methods of study.—The general method and characters studied are those used by Dunbar and Skinner (1937). However, it was found desirable to refine their methods of measurement somewhat, as is explained under the individual characters. In general, the measurements should be accurate to about one part in a hundred if practicable. This accuracy is sufficient but if the measurement can be made more accurately than this without greater effort, it is well to do so.

For best results, the best microscope available should be used for measurements. The ordinary stereoscopic binocular microscope used for studying other foraminifera is of very limited value in the study of fusulinids. A petrographic microscope is excellent. When used with crossed nicols a dark background is produced which considerably reduces eyestrain. A good biological microscope is also very good. The ordinary eyepiece micrometer is adequate and adaptable to all requirements. However from the standpoint of ease of use, the filar eyepiece micrometer is much better, although somewhat more expensive.

Half-length.—The half-length is measured in axial sections from the center of the proloculum to the point of greatest extent of the volution under consideration. In the past this measurement as such as been used as the half-length. Thus the distance A in figure 1



FIGS. *1–4*—Methods of measuring fusulinids. *1*, Half-length (A) as seen in axial section. *2*, Saggital section showing various possible orientations of axial sections, AB, CD, and EF. *3*, Axial sections in region of the proloculum, illustrating difficulties in interpreting orientation from axial sections. *4*, Method for consistently measuring radius vector in saggital sections.

would be taken as the half-length for volution $2\frac{1}{2}$. However, this may or may not be the correct measurement. Let us examine the orientation of this axial section with reference to its axis of coiling as viewed in a saggital section. Figure 2 represents a section perpendicular to the axis of coiling. The axial section is so cut as to contain the axis of coiling but may lie in any of the infinite number of planes containing this line. It might be along line AB or CD or EF, or any other plane, and there is no known means by which the section can be cut through a particular desired position. In other words, all axial sections are random sections as far as the plane of their orientation is concerned. If, then, the section is

oriented so that it cuts through the ¼ volution mark, as does CD in figure 2 the dimension of volution 4¾ will be used for volution 5, a measurement which would be less than the half-length since the half-length increases constantly at successive growth-stages.

Although it is impossible to determine the absolute orientation of an axial section, it is usually possible to estimate its true position within a quarter volution, which allows a fair degree of consistency. In general, the inner part of an axial section has one of three aspects. These are shown diagrammatically in figure 3. 3A shows the type found when the section is cut in the general region of line AB in figure 2. In this case the section cuts through the first volution at a position near the ½ volution point. In B, the section is cut in a position near EF on figure 2. In both A and B, the dimensions read for volutions 2 and 2½ are about correct. However, in 3C, the section is oriented in the region of line CD and the dimensions read for volutions 2 and 2½ are actually for about volutions 1¾ to 2¼. It then becomes necessary to find out what the half-length is for example at volution 2. This value may be readily estimated. The half-length is measured at the half volution intervals through the ontogeny (actually of course at volutions ¼, ¾, 1¼, etc.) These are then plotted on graph paper and the value for volutions ½, 1, 1½, 2, etc. interpolated and read off directly. This is admittedly not exact, but it improves the accuracy of recorded measurements.

At first consideration it would seem that one might determine the position of the section in the volution by measuring the height of volution, as at X in figure 3C, and then finding where this height occurred in the first volution. Unfortunately, the height of the volution at all stages is so variable that this method is completely useless.

Because of the lack of certainty as to orientation, determinations of the half-length are not wholly satisfactory. The published values for the various species are almost certainly less than the true values.

Radius vector.—The distance from the center of the proloculum to the outside of the wall of a specified volution is the radius vector of that volution. In published works the point where the first volution starts has not always been accurately defined. In this paper the selected point is the intersection of the wall with the line joining the center of the proloculum and the point of origin of the spirotheca as in figure 4. The radius vector of the first volution is measured at the end of the first volution and that of the second volution at the end of the second volution and so on. In the early *Tricites* there is often a secondary deposit of varying thickness on the outside of the tectum. This should be ignored in all measurements. Only measurements on saggital sections should be used.

Form ratio.—The form ratio is obtained by dividing the half length by the radius vector of a particular volution. The radius vector for this purpose is measured on the axial section and must be corrected for orientation in the same way that the half length is corrected. Then the form ratio is computed using these corrected measurements.

Tunnel angle.—The tunnel angle is that angle subtended by lines joining the edges of the tunnel with the center of the proloculum. It must be corrected for orientation in the same way as the half length. It is not very practicable to apply statistical analysis to the tunnel angle since it is really a function of two distinct factors, the width of the tunnel and the radius vector. The width of the tunnel would be a much better character to use, but the use of the tunnel angle is so firmly entrenched in the literature that it seems useless to attempt to displace it.

Height of volution.—The height of volution is the distance from the top of the tectum of one volution to the top of the tectum of the next. It is essentially a measure of the rate of the increase in the radius vector and is probably the least valuable of the characters used.

Wall Thickness.—In the genus *Triticites* this is the distance from the base of the keriotheca to the top of the tectum of a given volution. Care must be taken that none of the secondary deposit which often overlies the tectum is included or erratic results will be obtained. The tectum is so thin and uniform that separate measurement is of no purpose, and its thickness is included with the keriotheca.

Septal count.—The number of septa per volution for a particular volution is a valuable character in the Missourian *Triticites*. Many fusulinid workers have been inclined to minimize the importance of this character, but it is actually more useful than the height of volution.

Diameter of the proloculum.—If well centered sections are used, the diameter of the proloculum is an extremely useful character. If the proloculum is not exactly spherical, as is commonly the case, the greatest and least observed dimensions should be noted.

Septal fluting.—Much has been made of the importance of septal fluting as a specific character in *Triticites* and it certainly varies from species to species. However, in the present work it has not proved very valuable as a specific character. The fluting is so variable within a single species that it is impracticable to attempt any more than a generalized verbal description of its intensity. This is sufficiently accurate. Due to the curvature of the shell, tangential sections give such a distorted impression of the fluting that a verbal description is as good. These remarks are meant to apply only to primitive *Triticites* and not to more advanced forms.

The following method of description has been used in the present work. All descriptions refer to the fluting of the lower half or distal part of the septum. "Plane" describes unfluted septa. "Slightly fluted" describes fluting whose amplitude is less than $\frac{1}{3}$ the distance across a single one of the plications. "Moderately fluted" describes fluting more intense than slight but not so intense that adjacent septa touch. If opposed plications do touch, the fluting is described as strong.

PRESENTATION OF DATA

The manner of presentation of statistical data is a matter of great importance. In the past, these data for fusulinids have been presented in the form of numerical tables, which, it must be admitted, are quite indigestible. The tables are long, take up much space and are expensive to publish. Furthermore, numerical trends are difficult to visualize and it is not a simple matter to compare two sets of data. Finally, tabular data do not allow the prediction of the extent of the variation beyond the observed variation.

As has been intimated, the above objections either do not apply or apply only partially to the graphical method of presentation here used. Of the various methods which might be used, the following one seems to be simplest and the most practicable. The observed maximum, mean, and minimum measurements of a unit character, such as radius vector, are plotted against the volution at which they are measured on semi-logarithmic graph paper, the arithmetic scale being used for the volutions and the logarithmic scale for the character graphed (figure 5). Smooth limiting curves are then drawn showing the probable actual maxima and minima (contrasted with those observed) and a line is also drawn through the observed averages.

A word of explanation is needed concerning the use of logarithmic graphs in this connection. It is well known that growth in organisms follows more or less closely to a logarithmic function. Therefore, in order to obtain straight or moderately straight line graphs, the most easily interpreted type, it is necessary to use logarithmic scales on the graph. In graphing the volution number on an arithmetic scale, we are actually using a logarithmic scale, since the length around the spirotheca between successive volution increases logarithmically. The above statements may easily be verified by actual measurements as the writer has had occasion to do many times. Thus, by this method, a fairly straight line graph is obtained. A further advantage lies in the fact that the different volutions are given equal weight in the graph. If a purely arithmetic scale is used, for example, the absolute variation of a character may be shown in the sixth volution to be 100 times as great as in the first volution, although the per cent variation is exactly the same. The semi-logarithmic graph will, in effect, magnify the variation of the first volution, until it occupies as much space on the graph as the sixth volution, thus giving it its proportionately proper prominence. This allows the emergence of the fact that it is often possible to distinguish species in the early volutions that are exactly alike in some characters in the later volutions (e.g. species 9 and 10 in figure 8).

So far as the writer can determine, this importance of the early volutions has not previously been recognized. The plotting and reading of these graphs proceeds in exactly the same way as with arithmetic graphs.

IDENTIFICATION CHARTS

Often in identifying a species it may not be necessary to make an extensive study of it. The identification charts (figures 12 and 13) have been included to help in this determination. These charts show the range of a character in a particular volution, the half length and form ratio at the sixth volution, the radius vector, height of volution, wall thickness, tunnel angle, and septal count at the fifth volution and the diameter of the proloculum. The numbers at the top refer to species herein described. The solid lines show the observed variation with the maximum, minimum and mean indicated. The dotted portion is the probable variation beyond the observed variation which is taken from the graphs of the characters. For example, a specimen with a form ratio of 4.50 in the fifth volution, could not be referred to species 3, 5, 6, 7, or 8, thus eliminating half of the species here listed on the basis of one measurement.

SYSTEMATIC DESCRIPTIONS

Family FUSULINIDAE
Subfamily SCHWAGERININAE
Genus TRITICITES Girty, 1904

Genotype, *Triticities secalicus* (Say) = *Miliolites secalica* Say

Diagnosis.—Test fusiform. Wall consists of tectum of 5 to 8 microns thickness, and keriotheca of variable thickness; the alveoli are often thin walled and indistinct in the early species. May have a thin irregular secondary deposit corresponding to the outer tectorium of the Fusulininae. Septa nearly plane to strongly fluted so the adjacent septa touch; always irregular and blister-like at the poles. Septa pierced by a slit-like tunnel which flares steadily outward and is bounded by conspicuous chomata. Septal pores commonly conspicuous in outer volutions.

Range.—Basal Missourian to early Permian.

Discussion.—Although the statement has been made that *Triticites* differs from *Schwagerina* in the strength of the fluting, this generalization needs to be qualified. For example, the fluting of *Triticites plicatulus* Merchant and Keroher is as intense as that of *Schwagerina* although it occurs in the Missouri series and certainly belongs to *Triticites*. The best character for distinguishing the two genera is the chomata which are conspicuous in *Triticites* and obsolete or obsolescent in *Schwagerina*.

The species described below are arranged in ascending stratigraphic order. The essentials of four of the species described by Merchant and Keroher (1939) are included for the sake of completeness, although the writer has made no further observations on these species.

TRITICITES IRREGULARIS (Schellwien and Staff)
Species 8, text figs. 7–13

Triticites irregularis MERCHANT and KEROHER, *1939*, Jour. Paleontology, vol. 13, pp. 600–603.

Shape.—Elongate fusiform, with irregular constrictions. Form ratio, see text fig. 13, species 8.

Number of volutions.—Six to 6½ usual, a few with as many as 7.

Septa.—Nearly plane or slightly irregular across middle of shell becoming moderately fluted at the poles. Septal count, see text figs. 11 and 13, species 8. Septal pores small, rare, and confined to sixth and seventh volutions.

Wall.—Fine textured. Wall thickness, figs. 10 and 13, species 8.

Chomata.—Well developed, though irregular in shape. Absent only in last volution.

Half length.—See text fig. 12, species 8.

Tunnel angle.—See text figs. 7 and 12, species 8.

Radius vector.—See text figs. 8 and 12, species 8.

Height of volution.—See text figs. 9 and 13, species 8.

Diameter of proloculum.—See text fig. 13, species 8.

Discussion.—This is a very distinctive species and is not likely to be confused with other species here described.

Occurrence.—Winterset limestone, early Missourian Kansas, Missouri, and Iowa.

TRITICITES BURGESSAE
Burma, n. sp.
Plate 118, figs. 2 and 13; species 7,
text figs. 5–13.

Shape.—Bluntly fusiform, slightly inflated. Form ratio, see text figs. 6 and 12, species 7.

Number of volutions.—Mostly 5 to 5½, none with more than 6½ observed.

Septa.—Nearly plane or slightly irregular across middle of shell but becoming strongly fluted at the poles. Septal pores small, few, and inconspicuous in fifth and sixth volutions. Septal count, see text figs. 11 and 13, species 7.

Wall.—Very fine textured with very inconspicuous alveoli. Wall thickness, see text figs. 10 and 13, species 7.

Chomata.—Well developed even into last volution.

Half length.—See text figs. 5 and 12, species 7.

Tunnel angle.—See text figs. 7 and 12, species 7.

Radius vector.—See text figs. 8 and 12, species 7.

Height of volution.—See text figs. 9 and 13, species 7.

Diameter of proloculum.—See text fig. 13, species 7.

Discussion.—Individuals of this species are the smallest studied. The half length, wall thickness, septal count, and diameter of the proloculum are its most distinctive characters. The entire shell gives an impression of fragility.

Occurrence.—Westerville limestone, mid-Missourian. Types from the upper part of the limestone in the SE ¼ sec. 25, T. 69 N., R. 27 W., Decatur County, Iowa.

Types.—Syntypes 21210 and 21211, University of Wisconsin.

TRITICITES COLLUS Burma, n. sp.
Plate 118, figs. 9 and 14; species 3,
text figs. 5–13

Shape.—Elongate fusiform, slightly inflated, bluntly pointed extremities. Form ratio, see text figs. 6 and 12, species 3.

Number of volutions.—Normally about 7 volutions, a few have as many as 8.

Septa.—Moderately fluted over the width of the tunnel but over the rest of the length septa are strongly fluted so that adjacent septa touch. Septal pores small and few in the sixth and seventh volution. Septal count, see text figs. 11 and 13, species 3.

Wall.—Moderately fine textured. Alveoli readily seen but not prominent. Wall thickness, see text figs. 10 and 13, species 3.

Chomata.—Well developed except in last volution.

Half length.—See text figs. 5 and 12, species 3.

Tunnel angle.—See text figs. 7 and 12, species 3.

Radius vector.—See text figs. 8 and 12, species 3.

Height of volution.—See text figs. 8 and 12, species 3.

Diameter of proloculum.—See text fig. 13, species 3.

Discussion.—This species is very similar to *Triticites caccus* from the stratigraphically higher Argentine limestone. The two are most easily separated on the basis of the radius vector and wall thickness in the early volutions and by the septal count in the mature volutions. It is not likely to be confused with any of the other species.

Occurrence.—Upper part of Cement City limestone, mid-Missourian, in a roadside ditch on Highway 162 north of a ravine in sec. 10, T. 75 N., R. 28 W., Madison County, Iowa, about 3 miles west of Winterset, Iowa.

Types.—Syntypes 21214 and 21215, University of Wisconsin.

TRITICITES CACCUS Burma, n. sp.
Plate 118, figs. 4 and 5; species 1,
text figs. 5–13

Shape.—Fusiform with very blunt and rounded extremities, slopes quite straight. Form ratio, see text figs. 6 and 12, species 1.

Number of volutions.—Mostly 6 to 6½ volutions, but some with 7.

Septa.—Moderately fluted above the tunnel but strongly elsewhere fluted so that adjacent septa touch over remainder of shell. Septal pores very few and small. Septal count, see text figs. 11 and 13, species 1.

Wall.—Apparently fine textured but the appearance may be due to poor preservation. Wall thickness, see text figs. 10 and 13, species 1.

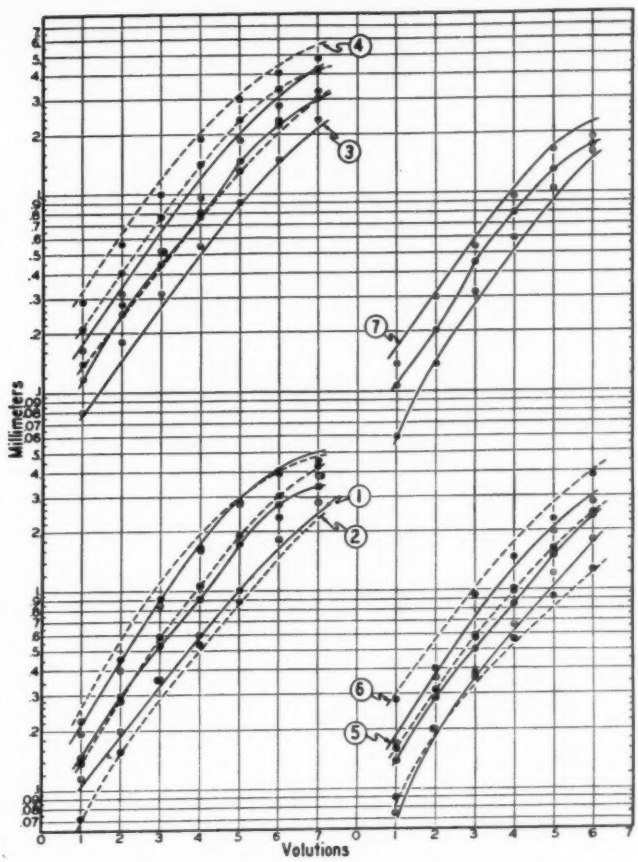


FIG. 5.—Half-lengths of Missourian *Triticites*. In this and following figures the solid black dots show the maximum, minimum, and mean measurements of the species graphed by the broken lines and the dot and circle the species graphed by the solid line. Numbers indicate species as follows: 1, *Triticites caccus;* 2, *T. neglectus;* 3, *T. collys;* 4, *T. primarius;* 5, *T. newelli;* 6, *T. secalicus;* 7, *T. burgessae;* 8, *T. irregularis;* 9, *T. tenuis;* 10, *T.* cf. *osagensis;* 11, *T. plicatulus.*

Chomata.—Well developed except in last volution.

Half length.—See text figs. 5 and 12, species 1.

Tunnel Angle.—See text figs. 7 and 12, species 1.

Radius vector.—See text figs. 8 and 12, species 1.

Height of volution.—See text figs. 9 and 13, species 1.

Diameter of proloculum.—See text figs. 13, species 1.

Discussion.—As has been brought out, this species is most similar to *Triticites collus.* It is not likely to be confused with other species.

Occurrence.—In a 1-inch shale parting 5 feet below the top of the Argentine limestone, mid-Missourian, in a quarry in NE ¼ sec. 7, T. 75 N., R. 29 W., Madison County, Iowa.

Types.—Syntypes 21212 and 21213, University of Wisconsin.

TRITICITES TENUIS Merchant and Keroher

Species 9, text figures 7–13

Triticites tenuis MERCHANT and KEROHER, *1939,* Jour. Paleontology, vol. 13, pp. 604–606.

Shape.—Slender and elongate, pointed extremities. Form ratio, see text fig. 12, species 9.

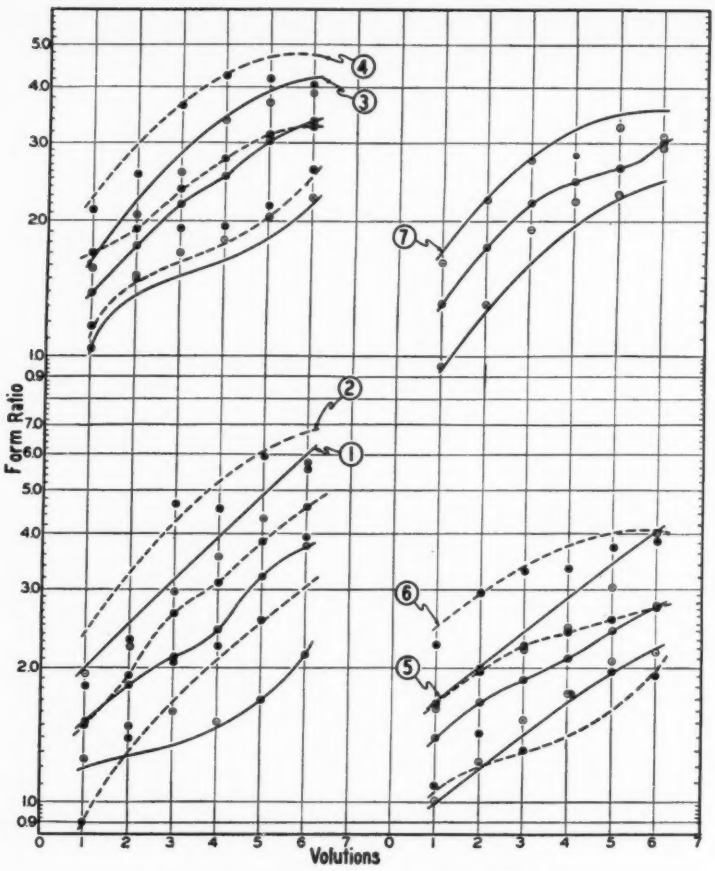


FIG. 6.—Form ratios of Missourian *Triticites*.

Number of volutions.—Mostly 6 or 6½, a few with as many as 7½ volutions.

Septa.—Moderately fluted, except at the poles where fluting is strong. Septal pores few and small in sixth and seventh volution. Septal count, see text figs. 11 and 13, species 9.

Wall.—Moderately coarse textured. Wall thickness, see text figs. 10 and 13, species 9.

Chomata.—Well developed except in last volution.

Half length.—See text fig. 12, species 9.

Tunnel angle.—See text figs. 7 and 12, species 9.

Radius vector.—See text figs. 8 and 12, species 9.

Height of volution.—See text figs. 9 and 13, species 9.

Diameter of proloculum.—See text fig. 13, species 9.

Discussion.—Most similar to *Triticites osagensis* Newell but readily distinguished from it, especially by the size of the proloculum.

Occurrence.—Island Creek shale, mid-Missourian, Kansas.

TRITICITES cf. OSAGENSIS Newell
Species 10, text figs. 7–13

Triticites cf. *osagensis* MERCHANT and KEROHER, *1939*, Jour. Paleontology, vol. 13, pp. 606–609.

Shape.—Elongate and slender with rather blunt ends. Form ratio. See text fig. 12, species 10.

Number of volutions.—Mostly 6 to 7 but some with as many as 8 volutions.

Septa.—Strongly fluted even across the center of the shell. Septal pores numerous and quite large in sixth and seventh volu-

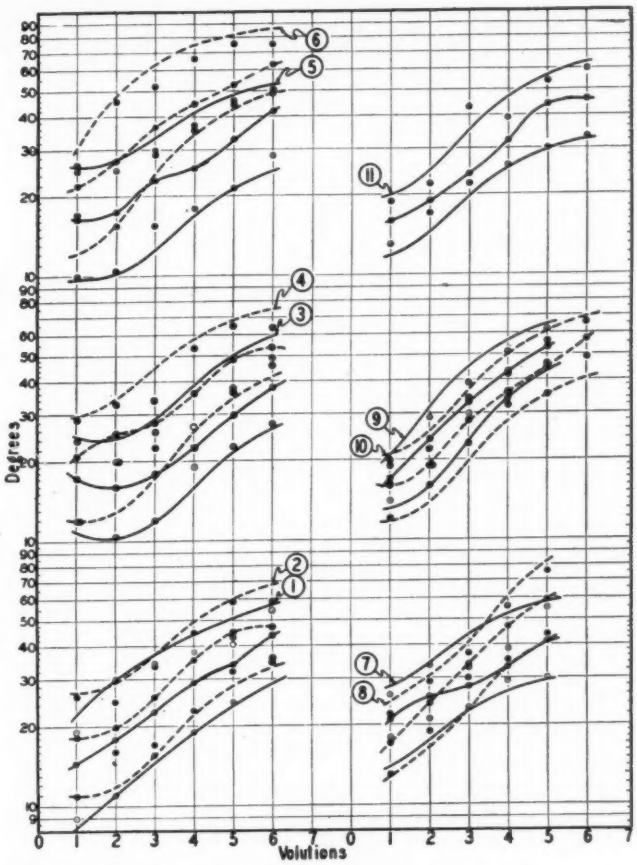


FIG. 7.—Tunnel angles of Missourian *Triticites*. 1, *T. caccus;* 2, *T. neglectus;* 3. *T. collus;* 4, *T. primarius;* 5, *T. newelli;* 6, *T. secalicus;* 7, *T. burgessae;* 8, *T. irregularis;* 9, *T. tenuis;* 10, *T.* cf. *osagensis;* 11, *T. plicatulus.*

tions. Septal count—see text figs. 11 and 13, species 10.

Wall.—Texture is moderately coarse. Wall thickness, see text figs. 10 and 13, species 10.

Chomata.—Well developed except in the last volution.

Half length.—See text fig. 12, species 10.

Tunnel angle.—See text figs. 7 and 12, species 10.

Radius vector.—See text figs. 8 and 12, species 10.

Height of volution.—See text figs. 9 and 13, species 10.

Diameter of proloculum.—See text fig. 13, species 10.

Discussion.—This species is most similar to *Triticites tenuis.*

Occurrence.—About 1 foot above the base of the Farley limestone, mid-Missourian, Kansas.

TRITICITES PLICATULUS Merchant and Keroher

Species 11, text figs. 7–13

Triticites plicatulus MERCHANT and KEROHER, *1939*, Jour. Paleontology, vol, 13, pp. 609–611.

Shape.—Subcylindrical with broadly rounded ends. Form ratio; see text fig. 12, species 11.

Number of volutions.—7 to 8 volutions on the average; rarely specimens attain 9.

Septa.—Fluting strong even across middle of the shell so that the loops of adjacent septa are in contact. Septal pores large but rare. Septal count, see text figs. 11 and 13, species 11.

Wall.—Moderately coarse textured. Wall thickness, see text figs. 10 and 13, species 11.

Chomata.—Rather weakly developed for a triticite. They are feebly developed in the penultimate volution and absent in the last.

Half length.—See text fig. 12, species 11.

Tunnel angle.—See text figs. 7 and 12, species 11.

Radius vector.—See text figs. 8 and 12, species 11.

Height of volution.—See text figs. 9 and 13, species 11.

Diameter of proloculum.—See text fig. 13, species 11.

Discussion.—This species is quite distinctive and is not likely to be confused with others.

Occurrence.—Types are from the Spring Hill member of the Plattsburg formation, mid-Missourian, Kansas.

TRITICITES NEGLECTUS Newell
Plate 118, figs. 3 and 6; species 2, text figs. 5–13

Triticites neglectus NEWELL, *1934*, Jour. Paleontology, vol. 8, pp. 422–423, pl. 52, figs. 2a–b, pl. 53, figs. 1a–b.

Shape.—Elongate fusiform with bluntly pointed extremities, tending to be subcylindrical. Form ratio, see text figs. 6 and 12, species 2.

Number of volutions.—Mostly with 5½ to 6½ volutions, rarely as many as 7½.

Septa.—Moderately fluted across the middle of the shell, becoming strongly fluted toward the poles. Septal pores rare and inconspicuous in sixth and seventh volutions. Septal count, see figs. 11 and 12, species 2.

Wall.—Moderately coarse textured. Wall thickness, see text figs. 10 and 13, species 2.

Chomata.—Well developed except in last volution.

Half length.—See text figs. 5 and 12, species 2.

Tunnel angle.—See text figs. 7 and 12, species 2.

Radius vector.—See text figs. 8 and 12, species 2.

Height of volution.—See text figs. 9 and 13, species 2.

Diameter of proloculum.—See text fig. 13, species 2.

Discussion.—This species described by Newell is for the first time here given statistical treatment. Its radius vector, wall thickness, and septal count are fairly characteristic. The material for the restudy was identified by Dr. Newell.

Occurrence.—Common in the Captain Creek member of the Stanton formation, upper Missourian, Kansas and Missouri.

TRITICITES PRIMARIUS Merchant and Keroher
Plate 118, figs. 1 and 8; species 4, text figs. 5–13

Triticites secalicus primarius MERCHANT and KEROHER, *1939*, Jour. Paleontology, vol. 13, p. 611, pl. 69, figs. 10–12.

Shape.—Elongate fusiform with inflated slopes and bluntly rounded extremities. Form ratio, see text figs. 6 and 12, species 4.

Number of volutions.—Most specimens have 6 to 6½, some as many as 7½ volutions.

Septa.—Nearly plane or very weakly fluted across the middle of the shell, becoming moderately fluted toward the extremities. Septal pores quite numerous and large in sixth and seventh volutions. Septal count, see text figs. 11 and 13, species 4.

EXPLANATION OF PLATE 118

FIGS. *1, 8*—*Triticites primarius* Merchant and Keroher, emend. Burma. *1*, Axial section ×7.5. *8*, Saggital section ×15. Topotypes. (p. 748)

2, 13—*Triticites burgessae* Burma, n. sp. *1*, Saggital section ×15, University of Wisconsin, no. 21210. *13*, Axial section ×7.5, University of Wisconsin no. 21211. Syntypes. (p. 744)

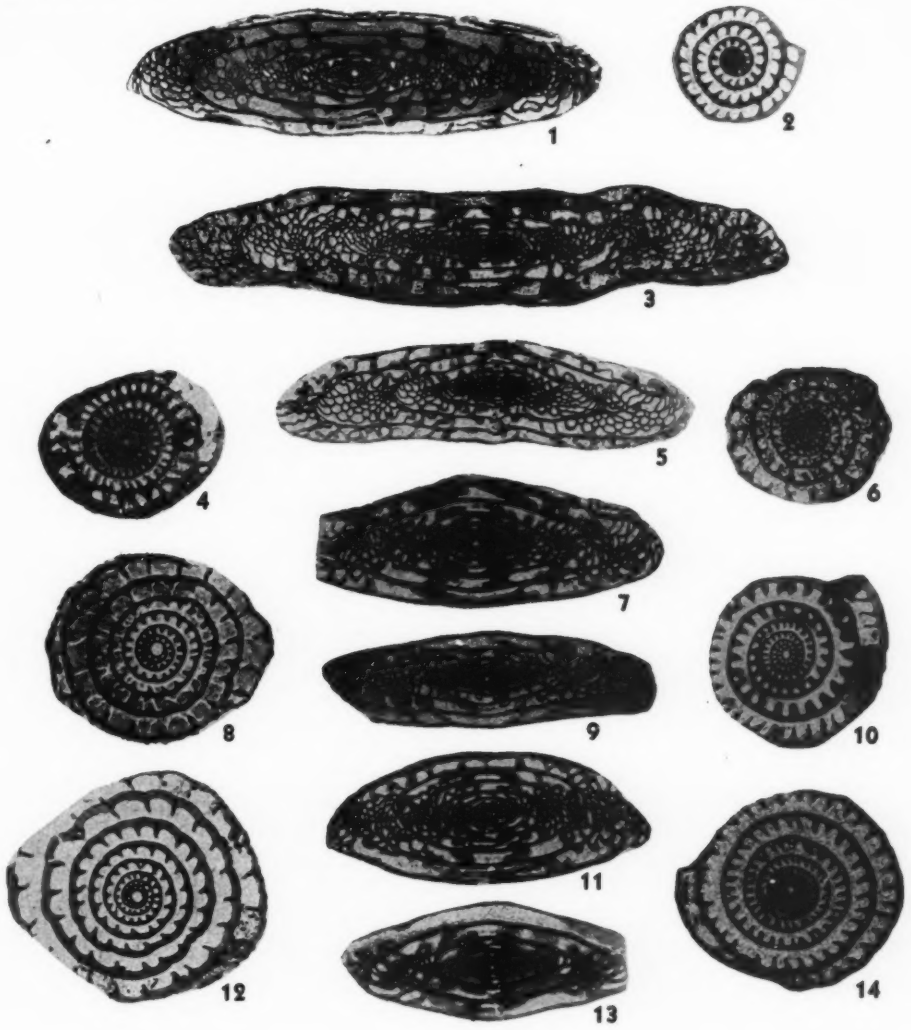
3, 6—*Triticites neglectus* Newell, *3*, Axial section ×7.5, *6*, Saggital section ×15. (p. 748)

4, 5—*Triticites caccus* Burma, n. sp. *4*, Saggital section ×15, University of Wisconsin 21212. *5*, Axial section ×7.5, University of Wisconsin no. 21213. Syntypes. (p. 744)

7, 10—*Triticites newelli* Burma, n. sp. *7*, Axial section ×7.5, University of Kansas no. 7603. *10*, Saggital section ×15. University of Kansas no. 7604. Syntypes. (p. 749)

9, 14—*Triticites collus* Burma, n. sp. *9*, Axial section ×7.5, University of Wisconsin no. 21214. *14*, Saggital section ×15, University of Wisconsin no. 21215. Syntypes. (p. 744)

11, 12—*Triticites secalicus* (Say). *11*, Axial section ×7.5. *12*, Saggital section ×15. Topotypes. (p. 751)



Burma, Mid-Pennsylvanian Fusulinids

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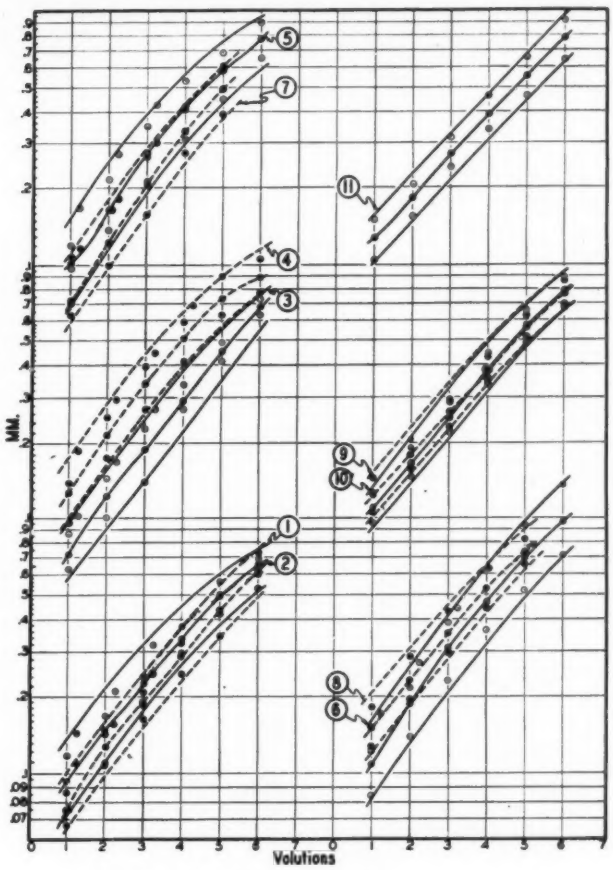

FIG. 8.—Radius vectors of Missourian *Triticites*.

Wall.—Rather coarse textured. Wall thickness, see text figs. 10 and 13, species 4.

Chomata.—Rather weakly developed; absent in the last volution.

Half length.—See text figs. 5 and 12, species 4.

Tunnel angle.—See text figs. 7 and 12, species 4.

Radius vector.—See text figs. 8 and 12, species 4.

Height of volution.—See text figs. 9 and 13, species 4.

Diameter of proloculum.—See text fig. 13, species 4.

Discussion.—This species was called a variety of *Triticites secalicus* by Merchant and Kerhoer. However, a careful comparison of the two has convinced the writer that the form is a distinct species. They differ markedly in half length, form ratio and wall thickness. For these reasons, I am elevating this variety to specific rank. A full description of typical *Triticites secalicus* is given below. This restudy is based on the same slides used by Merchant and Keroher in the original description.

Occurrence.—From the top of the Stoner member of the Stanton formation, Kansas. Type material from the center of the west side of sec. 31, T. 26 S., R. 15 E., Woodson County, Kansas.

TRITICITES NEWELLI Burma, n. sp.
Plate 118, figs. 7 and 10; species 5, text figs. 5–13

Triticites cf. *moorei* NEWELL, *1936*, Jour. Geol., vol. 44, pp. 29–31.

Shape.—Fusiform with straight slopes

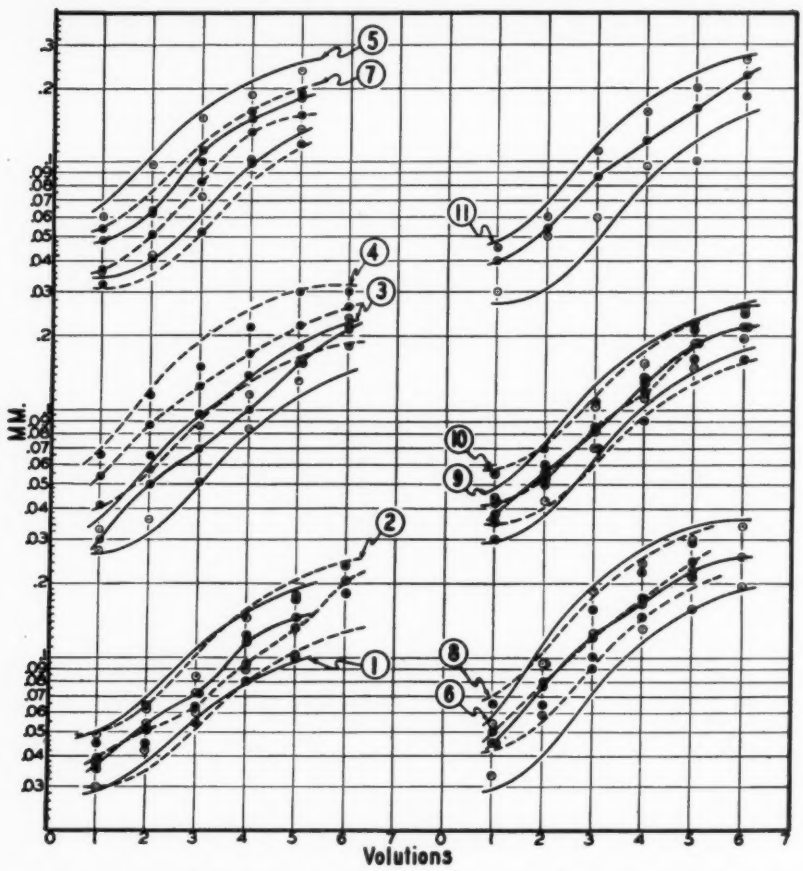

FIG. 9.—Height of volution of Missourian *Triticites*. 1, *T. caccus;* 2, *T. neglectus;* 3, *T. collus;* 4, *T. primarius;* 5, *T. newelli;* 6, *secalicus;* 7, *T. burgessae;* 8, *T. irregularis;* 9, *T. tenuis;* 10, *T.* cf. *osagensis;* 11, *T. plicatulus.*

and bluntly pointed extremities. Form ratio, see text figs. 6 and 12, species 5.

Number of volutions.—Mostly with 5 to 5½ volutions, a few with as many as 6½.

Septa.—Septa gently to moderately fluted across the middle becoming strongly fluted toward the poles. Septal pores small and inconspicuous in sixth volution. Septal count, see text figs. 11 and 13, species 5.

Wall.—Moderately coarse textured. Wall thickness, see text figs. 10 and 13, species 5.

Chomata.—Well developed except in last volution.

Half length.—See text figs. 5 and 12, species 5.

Tunnel angle.—See text figs. 7 and 12, species 5.

Radius vector.—See text figs. 8 and 12 species 5.

Height of volution.—See test figs. 9 and 13, species 5.

Diameter of proloculum.—See text fig. 13, species 5.

Discussion.—This distinctive form is not likely to be confused with other Missourian species. Newell (in Moore, Elias and Newell, 1936) referred this species to *Triticites* cf. *moorei*. Material was not at hand for a detailed study of *T. moorei*, but the two seem to be quite different. The radius vector is notably less in *T. newelli* and also the septal count is greater. The fluting of *T. newelli* is apparently more intense than that of *T. moorei*.

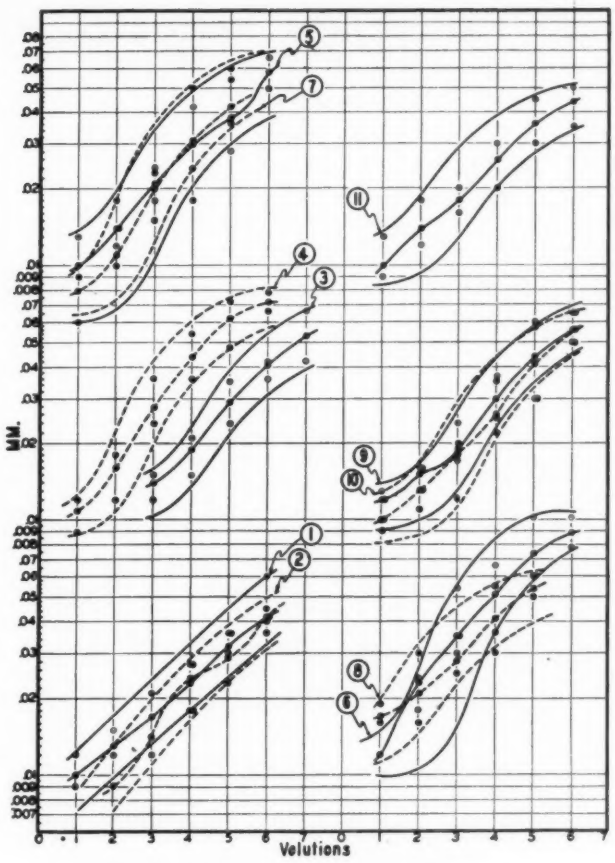

FIG. *10*.—Wall thickness of Missourian *Triticites*.

Occurrence.—From the South Bend limestone of the Stanton formation, Kansas. Types from the SE. cor. sec. 1, T. 15 S., R. 21 E., Kansas. From the Kansas Geological Survey collections.

Types.—Syntypes 7603 and 7604 Repository, University of Kansas.

TRITICITES SECALICUS (Say)
Plate 118, figs. 11 and 12; species 6, text figs. 6–13

Triticites secalicus (SAY), *1927*, Nebr. Geol. Surv., Ser. 2, Bull. 2, pp. 104–108, pl. 7, figs. 1–7.

Shape.—Fusiform with bluntly pointed ends and inflated lateral slopes. Form ratio, see text figs. 6 and 12, species 6.

Number of volutions.—Mostly 6 to 6½ volutions, more rarely with as many as 7½.

Septa.—Nearly plane or slightly fluted across the middle of the shell, becoming more strongly fluted toward the extremities.

Septal pores neither very large nor very numerous in sixth and seventh volutions. Septal count, see text figs. 11 and 13, species 6.

Wall.—Moderately coarse textured. Wall thickness, see text figs. 10 and 13, species 6.

Chomata.—Well developed except in last volution.

Half length.—See text figs. 5 and 12, species 6.

Tunnel angle.—See text figs. 7 and 12, species 6.

Radius vector.—See text figs. 8 and 12, species 6.

Height of volution.—See text figs. 9 and 13, species 6.

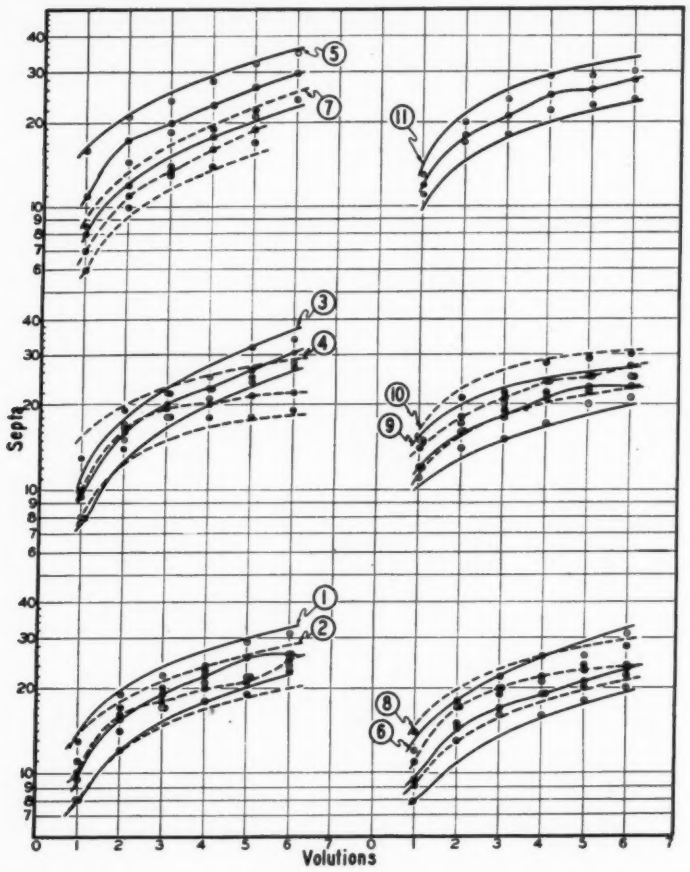

FIG. 11.—Septal counts of Missourian *Triticites*. 1, *T. caccus;* 2, *T. neglectus;* 3, *T. collus;* 4, *T. primarius;* 5, *T. newelli;* 6, *T. secalicus;* 7, *T. burgessae*; 8, *T. irregularis;* 9, *T. tenuis*; 10, *T.* cf. *osagensis;* 11, *T. plicatulus.*

Diameter of proloculum.—See text fig. 13, species 6.

Discussion.—Although this species was reported as ranging through a number of formations by Dunbar and Condra (1927), its range has been restricted due to increasing refinements of study and is apparently confined to the lower part of the Virgil series. Its description is introduced here because several Missourian species have been referred to it. The present description is based on topotype material kindly supplied by Dr. Condra of the Nebraska Geological Survey.

Occurrence.—Upper Heumader shale or basal Kereford limestone, lower Virgil, Snyderville Quarry, Nebraska.

THE ONTOGENY OF TRITICITES

Early in the progress of these studies it occurred to the writer that the rate of growth of fusulinids might be a valid specific character. With this in mind a fairly extensive study of the ontogeny of the Missourian *Triticites* was undertaken. This involved the measurement and plotting of the rate of growth of the radius vector, height of volution, and wall thickness at intervals of one-fourth of a volution. The rate of growth for this purpose was calculated , for example, by subtracting the radius vector at volution $2\frac{1}{4}$ from that at $2\frac{1}{2}$, keeping proper account of algebraic signs. These rates of growth of a given character at quarter volutions were

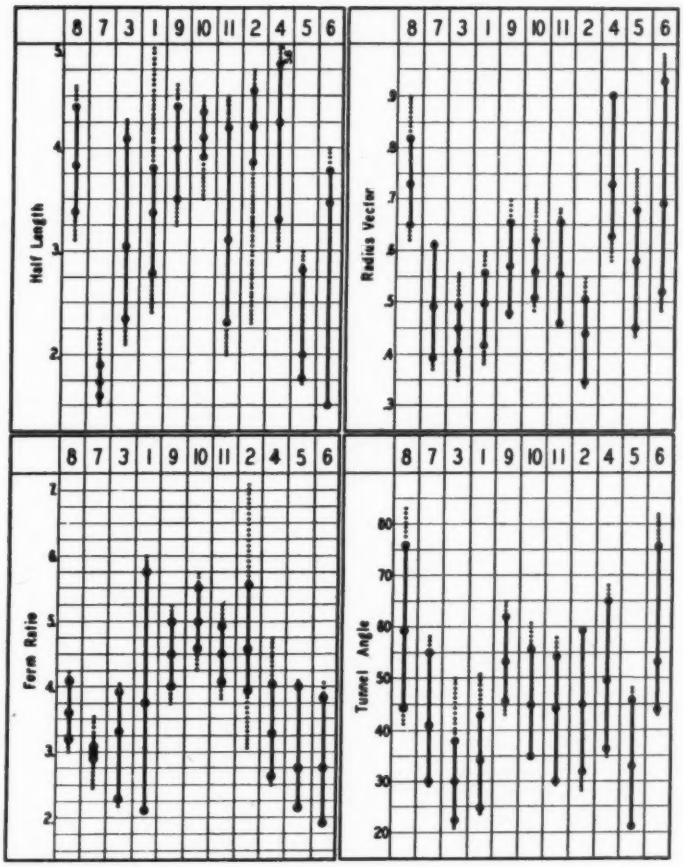

FIG. *12*.—Identification chart for Missourian *Triticites*. Half-length and form ration are given for 6th volution; tunnel angle and radius vector for the 5th volution. Solid lines observed variation; dots inferred variation.

averaged and the average plotted as shown in text figure 14.

The results were most unexpected. It was anticipated that a fairly smooth line or curve would be obtained. Instead, it appeared that the rate of growth was periodically speeded and retarded. This was shown with varying exactness. For example, in figure 14 the radius vector exhibits a spurt in growth once in each volution with nearly periodic regularity. The height of volution shows about the same tendency but less precisely, and the periodicity breaks down in the outermost volutions. The third type is shown by the graph of the wall thickness in which the periodicity is largely masked but growth still has a cyclical character. The growth of the half length, form ratio, and tunnel angle show this same tendency to periodicity. However, owing to the lessened accuracy of measurement due to the difficulty of determining the orientation of axial sections, and also since measurements can be taken only at half volution intervals, the graphs of their growth do not show the periodicity so well.

The cause of this variation in rate of growth is unknown. The cause might be either internal or external in origin, and at present there is little to choose. It is the writer's opinion, however, that the variation must be sought in the internal organization of the cell.

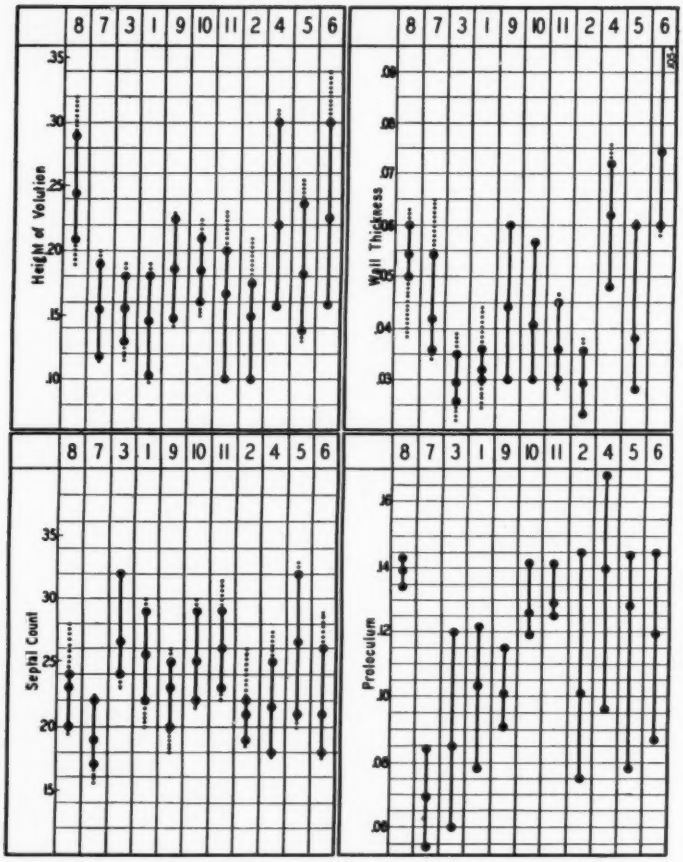

FIG. 13.—Identification chart for Missourian *Triticites*. 1, *T. caccus*; 2, *T. neglectus*; 3, *T. collus*; 4, *T. primarius*; 5, *T. newelli*; 6, *T. secalicus*; 7, *T. burgessae*; 8, *T. irregularis*; 9, *T. tenuis*; 10 *T.* cf. *osagensis*. 11, *T. plicatulus*. Septal count, height of volution, and wall thickness at the 5th volution. Solid lines, observed variation; dots, inferred variation.

THE PHYLOGENY OF TRITICITES

It was hoped that the present study might lead to at least an outline of the phylogeny of *Triticites*. Unfortunately it is not possible to make out anything very definite due to the complexity of the problem. However, it seems quite sure that the genus contains several phyletic lines which must eventually be separated. The following general trends seem to exist but the final word must await the complete delineation of phyletic lines. The septal fluting becomes more intense in the younger members of a phyletic series. The half length increases but there seems to be no marked trend in the radius vector. The form ratio decreases and the wall thickness and diameter of the proloculum increases. Trends in other characters are indeterminate.

REFERENCES

DUNBAR, C. D., and CONDRA, G. E., *1927*, The Fusulinidae of the Pennsylvanian system in Nebraska: *Nebraska Geol. Surv. Bull* 2, 2d ser., 135 pp.

MERCHANT, F. E., and KEROHER, R. P., *1939*, Some fusulinids from the Missouri series of Kansas: *Jour. Paleontology*, vol. 13, pp. 594–614.

NEWELL, N. D., *1934*, Some Mid-Pennsylvanian invertebrates from Kansas and Oklahoma: I. Fusulinidae, Brachiopoda: *Jour. Paleontology*, vol. 8, pp. 422–432.

SIMPSON, G. G., and ROE, A., *1939*, *Quantitative Zoology*, McGraw-Hill, New York.

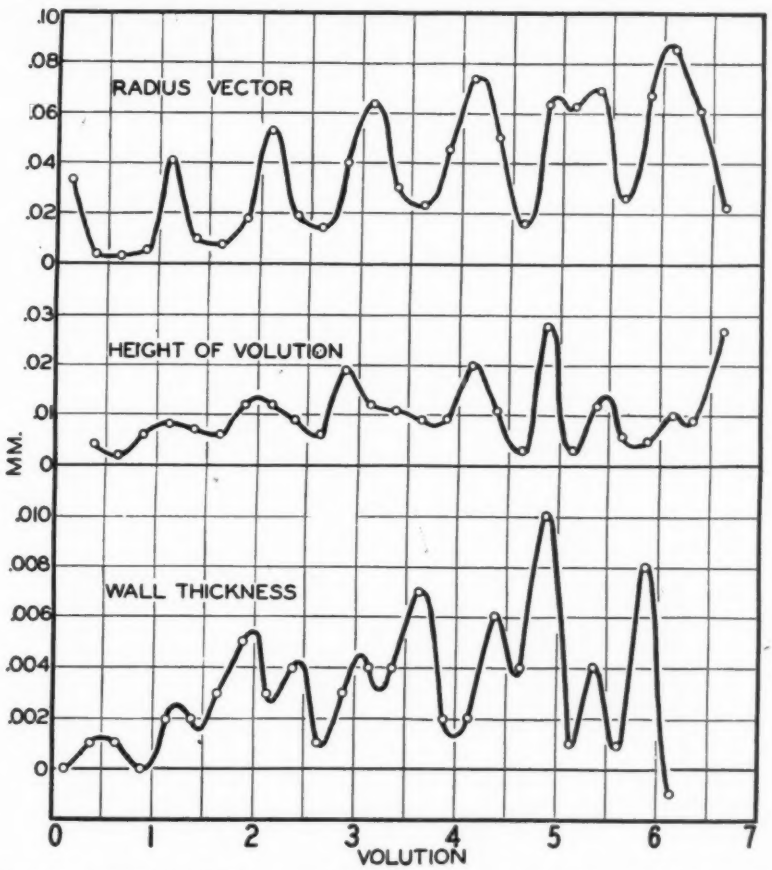

FIG. *14*.—Rhythmic growth in *Triticites tenuis* during ontogeny. The causes of these fluctuations are not obvious, but it is evident that the considerable variation during the growth of an individual has some bearing on the significance of measurements made in identifying a species.

MANUSCRIPT RECEIVED BY THE EDITOR JUNE 3, 1941.

JOURNAL OF PALEONTOLOGY, VOL. 16, NO. 6, PP. 756–763, NOVEMBER, 1942

BIBLIOGRAPHIC INDEX OF NEW GENERA AND FAMILIES OF PALEOZOIC OSTRACODA SINCE 1934[1]

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SINCE publication of the "Bibliographic Index of Paleozoic Ostracoda" by R. S. Bassler and Betty Kellett, as Geological Society of America Special Paper 1, at least 167 new generic names and 12 new family names of Paleozoic ostracodes have been proposed by authors whose bibliography comprises a list of at least 91 works. This is an indication of the great current interest in Paleozoic ostracodes because Bassler and Kellett list less than 200 generic names and only 18 family names in their 1934 bibliography.

In the alphabetically arranged list of families herein published, each family name is followed by the name of its author, with the year and page number of the reference in which his description of the family is found. An asterisk (*) preceding the family name indicates doubt as to the assignment of that family to the Ostracoda. The classification of families as proposed by Swartz (1936, pp. 543–557) is followed in this paper.

In the alphabetically arranged list of genera, those names which are included in the synonymy of other genera are printed in italics. As in the list of families an asterisk (*) preceding a generic name indicates that the genus is possibly not an ostracode. The name following the generic name is that of the author, with the year and page number of the reference in which his description of the genus is found. Following that is the specific name of the genotype and the age of the strata from which the genus was originally described. Last is the family designation. Where only one family name is given, it is that of the original author; where two family names are used, the first is my designation, and the original author's follows, enclosed in parenthesis. With the exception of *Whipplella* Holland, which is a fresh water genus, all of these genera are believed to be marine. The few new subgeneric names are indicated as such in the usual manner.

The references are listed alphabetically according to author, and chronologically according to year under that author.

Foreign literature as well as American was examined for the material presented in this paper, but it is probable that omissions have been made, especially of articles from the more obscure publications issued in the latter part of 1941. Only a few references published in 1942 have been included.

During the preparation of this work, five homonyms were discovered. These are:

Basslerella Bouček, 1936 (not Kellett)

Biflabellum Öpik, 1937 (not Doederlein)

Cornulina Coryell and Williamson, 1936 (not Conrad)

Denisonia Croneis and Bristol, 1939 (not Krefft)

Eustephanus Swartz and Swain, 1941 (not Reichenbach)

Platychilus Cooper, 1941 (not Jakolev)

Substitute names have been proposed by the original authors except for Bouček and Öpik, who could not be reached because of the interruption of communications caused by the war.

In the collection of these data, much aid was derived from the card index of ostracodes compiled by me for C. L. Cooper of the Illinois Geological Survey, under whose direction these lists have been prepared. To him, and to J. M. Weller, and W. H. Easton, also of the Illinois Survey, for pertinent comments, grateful thanks are expressed.

FAMILIES

Acronotellidae Swartz, 1936, p. 554

Aechminidae Swartz, 1936, p. 553.

***Alanellidae** Bouček, 1936, p. 71

This family, erected for the genus *Alanella* Bouček, which may not be an ostracode, is questionably included in this list. The new family Bolbozoidae, described by Bouček on page 60 of the same publication, is not included here because its genera are known not to be ostracodes.

Aparchitidae (Jones), 1901, p. 147.

Jones (1901, in Chapman, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 147) assigned this group subfamily rank under the Leperditiidae. Ulrich and Bassler (1923, Maryland Geol. Survey, Silurian vol., p. 296) raised it to family rank.

[1] Published with permission of the Chief of the Illinois State Geological Survey.

Bassler and Kellett (1934, Bibliographic Index of Paleozoic Ostracoda, Geol. Soc. America Spec. Paper 1, p. 14) included it in the Leperditellidae. Kay (1934, p. 331) restored it to family rank, and later (1940a, p. 241) reassigned part of the Aparchitidae of Ulrich and Bassler in the family Leperditellidae.

Drepanellidae Swartz, 1936, p. 552
Graphiadactyllidae Kellett, 1936, p. 773
Hollinidae Swartz, 1936, p. 551
Piretellidae Öpik, 1937, p. 110
Primitiopsidae Swartz, 1936, p. 555
Quasillitidae Coryell and Malkin, 1936, p. 18.

Coryell and Malkin, in November, 1936, included in this family the genera *Janetina*, *Jenningsina* and *Quasillites* all newly proposed by them, and *Graphiadactyllis* Roth, the latter having been previously assigned to the Kirkbyidae. In December, 1936, Kellett described the new family Graphiadactyllidae (see Moore, Weller and Knight, 1942), listing under it only the genus *Graphiadactyllis* Roth. The family diagnosis and discussion by Kellett applies equally well to the genera of Coryell and Malkin, and is very clear and complete. For this reason, and because priority is "not generally regarded in the disposition of family names,"[2] the family name Graphiadactyllidae Kellett is here adopted.

Ropolonellidae Coryell and Malkin, 1936, p. 6
Tetradellidae Swartz, 1936, p. 551

Kay (1940a, p. 240) proposed a classification in which some of the above families were reduced to the rank of subfamilies, part of this classification having been already used by Bouček (1936). It is as follows:

Beyrichiidae
- Beyrichiinae (Ulrich)
- Piretellinae (Öpik)
- Tetradellinae (Swartz)

Primitiidae
- Aechmininae Bouček, 1936, p. 53
- Bolliinae Bouček, 1936, p. 40
- Dilobellinae Kay, 1940a, p. 240

GENERA

Aechminaria Coryell and Williamson, 1936, p. 5—*A. nodosa* Coryell and Williamson. Niagaran. Aechminidae (Primitiidae).

***Alanella** Bouček, 1936, p. 71—*A. bohemica* Bouček. Silurian. Alanellidae.

Anisochilina Teichert, 1937b, p. 106—*A. punctulifera* Teichert. Middle Ordovician. Leperditiidae.

Antiparaparchites Coryell and Rogatz, 1932, p. 328—*A. reversus* Coryell and Rogatz = *Paraparchites* Ulrich and Bassler, by Kellett, 1936, p. 770.

Ardmorea Bradfield, 1935, p. 139—*A. symmetrica* Bradfield. Pennsylvanian. ?Leperditellidae.

Bairdiacypris Bradfield, 1935, p. 93—*B. deloi* Bradfield. Pennsylvanian. Bairdiidae.

Bairdiacypris Bradfield should not to be confused with *Bairdiocypris* Kegel, 1931, which was proposed as a subgenus of *Bythocypris* Brady, and which Bassler and Kellett (1934) included in the synonymy of that genus. Although the spellings of these names differ by only a single letter, they are not homonyms. (Article 36, International Rules of Zoological Nomenclature).

Bairdiolites Croneis and Gale, 1938, p. 288—*B. crescentis* Croneis and Gale. Chester. Bairdiidae.

Bairdites Coryell and Malkin, 1936, p. 9—*B. deltasulcata* Coryell and Malkin. Hamilton. Bairdiidae.

Balantoides Morey, 1935b, p. 479—*B. quadrilobus* Morey. Amsden. Beyrichiidae (Kirkbyidae).

Balticella Thorslund, 1940, p. 179—*B. oblonga* Thorslund. Trenton. ?Beyrichiidae (Kloedenellidae).

Bassleratia Kay, 1934, p. 341—*B. typa* Kay. Mohawkian. Tetradellidae (Beyrichiidae).

Basslerella Bouček, 1936, p. 60 (not Kellett) = *Boucia* Agnew.

Basslerella Bouček, 1936, is a junior homonym of *Basslerella* Kellett, 1935, and a new name, *Boucia*, is here proposed to replace it.

Basslerites Teichert, 1937b, p. 116 (not Howe) = *Rayella* Teichert, by Teichert, 1939, p. 622.

Bellornatia Kay, 1934, p. 342—*B. tricollis* Kay. Ordovician. Tetradellidae (Beyrichiidae).

***Berounella** Bouček, 1936, p. 65—*B. rostrata* Bouček. Silurian. ?Beecherellidae.

Bicornella Coryell and Cuskley, 1934, p. 3—*B. tricornis* Coryell and Cuskley. Haragan. Primitiidae.

Biflabellum Öpik, 1937, p. 102 (not Doederlein) = *Öpikium* Agnew.

Biflabellum Öpik, 1937 is a junior homonym of *Biflabellum* Doederlein, 1913, and a new name. *Öpikium*, is here proposed to replace it, because it is not possible to correspond with the author.

Binodella Bradfield, 1935, p. 140—*B. binoda* Bradfield. Pennsylvanian. Kirkbyidae.

Bolbiprimitia Kay, 1940a, pp. 234, 240—*Halliella fissurella* Ulrich and Bassler. Decorah. Primitiidae.

***Boucia** Agnew, new name for *Basslerella* Bouček (not Kellett)—*Basslerella ornatissima* Bouček. Silurian. ?Entomidae.

Boursella Turner, 1939, p. 13—*B. trilobita* Turner. Middle Devonian. Beyrichiidae.

***Budnianella** Bouček, 1936, p. 69—*B. caroli* Bouček. Silurian. *Incertae sedis* (Kirkbyidae).

Bufina Coryell and Malkin, 1936, p. 8—*B. elata* Coryell and Malkin. Hamilton. Ropolonellidae.

Carboprimitia Croneis and Funkhouser, 1938, p. 337—*C. depressa* Croneis and Funkhouser. Chester. Primitiidae.

Cavellinella Bradfield, 1935, p. 136—*C. casei* Bradfield. Pennsylvanian. Cytherellidae.

[2] Schenck, E. T. and McMasters, J. H., 1936, Procedure in Taxonomy, p. 5.

Ceratopleurina Coryell and Johnson, 1939, p. 221—*C. mimiri* Coryell and Johnson = *Glyptopleura* Girty, by Cooper, 1941, p. 42.

Chesterella Croneis and Gutke, 1939, p. 45—*C. fissurata* Croneis and Gutke. Chester. Kloedenellidae.

Coelonella Stewart, 1936, p. 743—*Isochilina? scapha* Stewart. Middle Devonian. ?Leperditellidae.

Conchoprimitia Öpik, 1935a, p. 4—*C. gammae* Öpik. Ordovician. Primitiidae.

The genotype of *Conchoprimitia* Öpik, 1935 (not 1937 as stated by Kay, 1940a, p. 248) is *C. gammae* Öpik (not *C. tallinnensis* Öpik, as designated by Kay, 1940a, p. 248).

Cooperatia Tolmachoff, 1937, p. 78, new name for *Cooperia* Tolmachoff (not Ransom)—*Cooperia granum* Tolmachoff. Ordovician. ?Beecherellidae.

Cooperia Tolmachoff, 1926, p. 35 (not Ransom) = *Cooperatia* Tolmachoff, by Tolmachoff, 1937, p. 78.

Cornulina Coryell and Williamson, 1936, p. 2 (not Conrad) = *Waldronites* Coryell and Williamson, by Coryell and Williamson, 1942.[3]

Coryellina Bradfield, 1935, p. 35—*C. capax* Bradfield. Pennsylvanian. Primitiidae.

Coryellina Kellett, 1935, p. 138 (not Bradfield) = *Coryellites* Kellett, by Kellett, 1936, p. 775.

Coryellites Kellett, 1936, p. 775, new name for *Coryellina* Kellett (not Bradfield)—*Coryellina firma* Kellett. Upper Pennsylvanian. Bairdiidae.

Cribroconcha Cooper, 1941, p. 29—*C. costata* Cooper. Chester. Bairdiidae.

Ctenoloculina Bassler, 1941, p. 22—*Tetradella cicatricosa* Warthin. Hamilton. Tetradellidae.

Ctenonotella Öpik, 1937, p. 101—*C. elongata* Öpik. Ordovician. Tetradellidae (Beyrichiidae).

Cyrtocypris Coryell and Williamson, 1936, p. 7—*C. subovata* Coryell and Williamson. Niagaran. Bairdiidae.

Daleiella Bouček, 1937, p. 7—*Cythere corbuloides* Jones and Holl. Silurian. *Incertae Sedis* (Bairdiidae).

Deloia Croneis and Thurman, 1938, p. 307—*D. serrata* Croneis and Thurman. Chester. Kloedenellidae.

Denisonella Croneis and Bristol, 1942, p. 777, new name for *Denisonia* Croneis and Bristol (not Krefft)—*Denisonia cincta* Croneis and Bristol. Chester. Kloedenellidae.

Denisonia Croneis and Bristol, 1939, p. 76 (not Krefft) = *Denisonella* Croneis and Bristol, by Croneis and Bristol, 1942, p. 777.

Dihogmochilina Teichert, 1937b. p. 153—*Isochilina latimarginata* Jones. Niagaran. Leperditiidae.

Discoidella Croneis and Gale, 1938, p. 276—*D. simplex* Croneis and Gale. Chester. Kirkbyidae.

Ectodemites Cooper, 1941, p. 49—*E. primus* Cooper. Chester. Kirkbyidae.

Ectoprimitia Bouček, 1936, p. 45, subgenus of *Haploprimitia*—*Haploprimitia* (*Ectoprimitia*) *corrugata krausei* Bouček. Silurian. Primitiidae.

Eucraterellina Wilson, 1935, p. 640—*E. randolphi* Wilson. Lower Devonian. Thlipsuridae.

Eustephanella Swartz and Swain, 1942, p. 674, new name for *Eustephanus* Swartz and Swain (not Reichenbach)—*Eustephanus catastephanes* Swartz and Swain. Onondaga. Thlipsuridae.

Eustephanus Swartz and Swain (not Reichenbach) = *Eustephanella* Swartz and Swain, by Swartz, 1942.

Favulella Swartz and Swain, 1941, p. 438—*Bythocypris favulosa* Jones. Onondaga. ?Thlipsuridae.

Geffenina Coryell and Sohn, 1938, p. 600—*G. marmerae* Coryell and Sohn. Mauch Chunk. Kloedenellidae.

Geffenites Coryell and Sohn, 1938, p. 601—*G. jungae* Coryell and Sohn. Mauch Chunk. Kloedenellidae.

Geisina Johnson, 1936, p. 21—*Beyrichiella gregaria* Ulrich and Bassler. Upper Pennsylvanian. Kloedenellidae.

Gillina Coryell and Johnson, 1939, p. 217—*G. vitharri* Coryell and Johnson. Chester. Kloedenellidae (Kirkbyidae).

Girtyites Coryell and Booth, 1933, p. 261 (not Wedekind) (= *Kegelites* Coryell and Booth) = *Amphissites* Girty, by Johnson, 1936, p. 29, and Kellett, 1936, p. 772.

Glyptopleurites Coryell and Johnson, 1939, p. 219—*G. tyri* Coryell and Johnson = *Glyptopleura* Girty, by Cooper, 1941, p. 42.

Glyptopleuroides Croneis and Gale, 1938, p. 283—*G. insculptus* Croneis and Gale. Chester. Glyptopleuridae.

Golcondella Croneis and Gale, 1938, p. 262—*G. sulcata* Croneis and Gale. Chester. Drepanellidae.

Hallatia Kay, 1934, p. 335—*H. healeyensis* Kay. Mohawkian. Primitiidae.

Hamiltonella Stewart, 1936, p. 756—*Leperditia punctulifera* Hall. Middle Devonian. Cytherellidae (Bairdiidae).

Hardinia Coryell and Rozanski, 1942, p. 146—*H. concava* Coryell and Rozanski. Glen Dean. ?Youngiellidae.

Harltonella Bradfield, 1935, p. 118—*H. ardmorensis* Bradfield. Pennsylvanian. Bairdiidae.

Hastacypris Croneis and Gutke, 1939, p. 60—*H. bradyi* Croneis and Gutke. Chester. Bairdiidae.

Haworthina Kellett, 1935, p. 161—*Bairdia bulleta* Harris and Lalicker. Permian. Bairdiidae (?Cypridae).

Healdiacypris Bradfield, 1935, p. 103—*H. perplexa* Bradfield. Pennsylvanian. Bairdiidae.

Healdioides Coryell and Rozanski, 1942, p. 148—*H. diversus* Coryell and Rozanski. Glen Dean. Bairdiidae. (Healdiidae).

Hesperidella Öpik, 1937, p. 113—*Primitia estonica* Bonnema. Ordovician. Piretellidae.

Heterochilina Poulsen, 1937, p. 60—*H. obliqua* Poulsen. Lower Ordovician. Leperditiidae.

Hogmochilina Solle, 1935, p. 20, subgenus of *Isochilina*—*Isochilina* (*Hogmochilina*) *elliptica* Solle. Devonian. Leperditiidae.

[3] Personal communication.

Holtedahlina Solle, 1935, p. 46 (not Foerste) = *Holtedahlites* Solle, 1936, p. 282.

Holtedahlites Solle, 1936, p. 282, new name for *Holtedahlina* Solle (not Foerste)—*Holtedahlina teres* Solle. Devonian. Leperditiidae.

Hypotetragona Morey, 1935a, p. 326—*H. impolita* Morey. Bushberg. Primitiidae (Cytherellidae).

Idiomorpha Croneis and Gale, 1938, p. 284 (not Förster) = *Idiomorphina* Croneis and Gale, by Croneis, 1939, p. 28.

Idiomorphina Croneis and Gale, in Croneis, 1939, p. 28, new name for *Idiomorpha* Croneis and Gale, 1938, p. 284—*Idiomorpha insignis* Croneis and Gale = *Glyptopleura* Girty, by Cooper, 1941, p. 42.

Incisurella Cooper, 1941, p. 32—*I. prima* Cooper. Chester. Bairdiidae.

Janetina Coryell and Malkin, 1936, p. 19—*J. harrietensis* Coryell and Malkin. Graphiadactyllidae (Quasillitidae).

Jenningsina Coryell and Malkin, 1936, p. 19—*Graphiodactylus catenulatus* Van Pelt. Hamilton. Graphiadactyllidae (Quasillitidae).

Karlsteinella Bouček, 1936, p. 67—*K. reticulata* Bouček. Silurian. Beyrichiidae.

Kegelites Coryell and Booth, 1933, 2nd page of table of contents of Amer. Midland Nat., vol. 14, new name for *Girtyites* Coryell and Booth, p. 261 of the same volume—*Girtyites spinosus* Coryell and Booth = *Amphissites* Girty, by Kellett, 1936, p. 772.

Kellettina Swartz, 1936, p. 585—*Ulrichia robusta* Kellett. Lower Devonian. Kirkbyidae.

Kirkbyites Johnson, 1936, p. 35—*K. upsoni* Johnson. Upper Pennsylvanian. Kirkbyidae.

Kloedenellina Coryell and Johnson, 1939, p. 216—*K. heimdalli* Coryell and Johnson. Chester. Kloedenellidae.

***Laddella** Spivey, 1939, p. 175—*L. insueta* Spivey. Maquoketa. *Incertae Sedis.*

Lamarella Croneis and Funkhouser, 1938, p. 336—*L. thurmani* Croneis and Funkhouser = *Sansabella* Roundy, by Cooper, 1941, p. 60.

Leightonella Croneis and Gale, 1938, p. 263—*L. torta* Croneis and Gale = *Deloia* Croneis and Thurman, by Cooper, 1941, p. 54.

Lindsayella Coryell and Williamson, 1936, p. 1—*L. rugosa* Coryell and Williamson. Niagaran. Primitiidae.

Lochriella Scott, 1942, p. 155—*L. otterensis* Scott. Chester. Kloedenellidae. The name *Lochriella* was first published by Cooper (1940, p. 57) without designation of genotype and referred to Scott (Art. 25c 3, Int. Rules).

Lokius Coryell and Johnson, 1939, p. 216—*L. sigynae* Coryell and Johnson = *Perprimitia* Croneis and Gale, by Cooper, 1941, p. 58.

Lucasella Stewart, 1936, p. 761—*L. mundula* Stewart. Middle Devonian. Cytherellidae (Bairdiidae).

Macrocyproides Spivey, 1939, p. 174—*M. clermontensis* Spivey. Maquoketa. Bairdiidae.

Mammoides Bradfield, 1935, p. 36—*M. mammillata* Bradfield = *Aechminella* Harlton, by Kellett, 1936, p. 771.

Maratia Kay, 1940a, p. 258—*M. mara* Kay. Decorah. Primitiidae.

Menoeidina Stewart, 1936, p. 762—*M. subreniformis* Stewart. Middle Devonian. Cytherellidae.

Mesoglypha Cooper, 1941, p. 44—*M. mediocre* Cooper. Chester. Glyptopleuridae.

Microcoelonella Coryell and Sohn, 1938, p. 597—*M. scanta* Coryell and Sohn. Mauch Chunk. ?Leperditellidae.

Microparaparchites Croneis and Gale, 1939, p. 69—*M. spinosus* Croneis and Gale. Chester. Leperditellidae.

Milleratia Swartz, 1936, p. 567—*Beyrichia cincinnatiensis* Miller. Ordovician. Primitiidae.

Mirochilina Bouček, 1936, p. 51—*M. jarovensis* Bouček. Silurian. Primitiidae.

Monoceratella Teichert, 1937b, p. 114—*M. teres* Teichert. Middle Ordovician. Acronotellidae.

Neoaparchites Bouček, 1936, p. 39; Teichert, 1937a, p. 45—*Primitia obsoleta* Jones and Holl. Ordovician. Leperditellidae (Aparchitidae).

This group, described as a subgenus by Bouček, was raised to generic rank by Teichert.

Neokloedenella Croneis and Funkhouser, 1938, p. 341—*N. prima* Croneis and Funkhouser. Chester. Kloedenellidae.

Novakina Bouček, 1936, p. 56—*N. applanans* Bouček. Silurian. Primitiidae.

Nuferella Bradfield, 1935, p. 45—*N. infrequens* Bradfield. Pennsylvanian. Kloedenellidae.

Octonariella Bassler, 1941, p. 21—*O. typica* Bassler. Onondaga. Thlipsuridae.

Opikatia Kay, 1940a, p. 264—*O. emaciata* Kay. Decorah. Beyrichiidae.

Öpikella Thorslund, 1940, p. 181—*Ö. tvaerensis* Thorslund. Trenton. ?Leperditellidae (Kirkbyidae).

Öpikium Agnew, new name for *Biflabellum* Öpik (not Doederlein)—*Biflabellum tenerum* Öpik. Ordovician. Beyrichiidae.

Paenaequina Solle, 1935, p. 44—*P. pentagonalis* Solle. Devonian. Leperditiidae.

Parabolbina Swartz, 1936, p. 570—*Ctenobolbina granosa* Ulrich. Lower Devonian. Hollinidae.

Paracavellina Cooper, 1941, p. 37—*P. elliptica* Cooper. Chester. Cytherellidae.

Paragraphylus Coryell and Rozanski, 1942, p. 144—*P. reticulatus* Coryell and Rozanski. Chester. ?Youngiellidae (Quasillitidae).

Parahealdia Coryell and Cuskley, 1934, p. 3—*P. pecorella* Coryell and Cuskley. Haragan Primitiidae.

Paraschmidtella Swartz, 1936, p. 563—*P. dorsopunctata* Swartz. Lower Devonian. Aparchitidae (Leperditellidae).

Parenthatia Kay, 1940a, p. 259—*Moorea punctata* Ulrich. Decorah. Primitiidae.

Perprimitia Croneis and Gale, 1938, p. 257—*P. robusta* Croneis and Gale. Chester. Primitiidae.

Persansabella Coryell and Sohn, 1938, p. 598—*P. bradfieldi* Coryell and Sohn = *Sansabella* Roundy by Cooper, 1941, p. 59.

Piretella Öpik, 1937, p. 111—*P. acmaea* Öpik. Ordovician. Piretellidae.

Placentella Wilson, 1935, p. 636—*P. delicata* Wilson. Lower Devonian. Primitiidae.

Plagionephrodes Morey, 1935, p. 318—*P. uninodosus* Morey. Bushberg. Thlipsuridae.

Platychilella Cooper, 1942, p. 777, new name for *Platychilus* Cooper (not Jakolev)—*Platychilus ovoides* Cooper. Chester. Beyrichiidae.

Platychilus Cooper, 1941, p. 38 (not Jakolev) = *Platychilella* Cooper, by Cooper, 1942, p. 777.

Polyceratella Öpik, 1937, p. 101—*Ulrichia kukersiana* Bonnema. Ordovician. ?Beyrichiidae.

Polytylites Cooper, 1941, p. 51—*P. geniculatus* Cooper. Chester. Kirkbyidae.

Ponderodictya Coryell and Malkin, 1936, p. 15—*P. bispinulata* Coryell and Malkin. Hamilton. Cytherellidae.

Proparaparchites Cooper, 1941, p. 62—*P. ovatus* Cooper. Chester. Leperditellidae.

Pseudostrepula Öpik, 1937, p. 116—*Strepula kukersiana* Bonnema. Ordovician. Piretellidae.

Pterocodella Croneis and Gale, 1938, p. 260—*P. mirablilis* Croneis and Gale = *Tetrasacculus* Stewart, by Cooper, 1941, p. 63.

Pullvillites Öpik, 1937, p. 119—*P. triangulum* Öpik. Ordovician. ?Acronetellidae.

Punctaparchites Kay, 1934, p. 331—*Cytheropsis rugosus* Jones = *Macronotella* Ulrich, by Kay, 1940a, p. 245.

Pyxiprimitia Swartz, 1936, p. 568—*P. ventriclefta* Swartz. Lower Devonian. Primitiidae.

Quasillites Coryell and Malkin, 1936, p. 18—*Q. obliquus* Coryell and Malkin. Hamilton. Graphiadactyllidae (Quasillitidae).

Rakverella Öpik, 1937, p. 109—*R. spinosa* Öpik. Ordovician. Piretellidae (Beyrichiidae).

Ranapeltis Bassler, 1941, p. 26—*R. typicalis* Bassler. Onondaga. Thlipsuridae.

Rayella Teichert, 1939, p. 622, new name for *Basslerites* Teichert, (not Kellett)—*Basslerites hanseni* Teichert. Decorah. Beecherellidae.

Raymondatia Kay, 1934, p. 342—*R. goniglypta* Kay. Mohawkian. Tetradellidae (Beyrichiidae).

Reversabella Coryell and Johnson, 1939, p. 221—*R. njorthi* Coryell and Johnson = *Sansabella* Roundy, by Cooper, 1941, pp. 57, 60.

Richina Coryell and Malkin, 1936, p. 3—*R. truncata* Coryell and Malkin. Hamilton. Tetradellidae (Beyrichiidae).

Rigidella Öpik, 1937, p. 117—*Steusloffia mitis* Öpik. Ordovician. Piretellidae.

Rothella Wilson, 1935, p. 643—*Dizygopleura recta* Roth. Lower Devonian. Thlipsuridae.

Roundyella Bradfield, 1935, p. 66—*R. simplicissimus* Bradfield. Pennsylvanian. Kirkbyidae.

Rudderina Coryell and Malkin, 1936, p. 6—*R. extensa* Coryell and Malkin. Hamilton. Ropolonellidae.

Saccelatia Kay, 1940a, p. 242—*Aparchites erectus* Ulrich. Decorah. ?Aparchitidae (Lepeditellidae).

Sargentina Coryell and Johnson, 1939, p. 223—*S. allani* Coryell and Johnson. Chester. Cytherellidae.

Scaberina Bradfield, 1935, p. 67—*S. nodomarginata* Bradfield. Pennsylvanian. Kirkbyidae.

Spinovina Coryell and Malkin, 1936, p. 17—*S. distributa* Coryell and Malkin. Hamilton. Cytherellidae.

***Steusloffina** Teichert, 1937b, p. 120—*S. ulrichi* Teichert. Middle Ordovician. ?Beecherellidae (Bairdiidae).

Stibus Swartz and Swain, 1941, p. 436—*S. kothornostibus* Swartz and Swain. Onondaga. Thlipsuridae.

Strepulites Coryell and Malkin, 1936, p. 5—*S. mocki* Coryell and Malkin. Hamilton. Thlipsuridae.

Suchonella Spizharsky, 1937, p. 159—*S. typica* Spizharsky. Permian. *Incertae Sedis.*

Suchonellina Spizharsky, 1937, p. 156—Permian. *Incertae Sedis.*

The two foregoing genera were described in 1937 by Spizharsky, not as new, but with his name following them, implying their previous description in another publication not listed in the bibliography. No genotype was named for *Suchonellina* in the 1937 publication.

Tallinnella Öpik, 1937, p. 88—*T. dimorpha* Öpik. Ordovician. Tetradellidae (Beyrichiidae).

Tetrasacculus Stewart, 1936, p. 744—*T. bilobus* Stewart. Middle Devonian. Primitiidae.

Tetratylus Cooper, 1941, p. 34—*T. ellipticus* Cooper. Chester. Bairdiidae.

Thlipsurina Bassler, 1941, p. 26—*T. elongata* Bassler. Onondaga. Thlipsuridae.

Thomasatia Kay, 1934, p. 337—*T. falcicosta* Kay. Ordovician. Tetradellidae (Beyrichiidae).

Tomiella Spizharsky, 1937, p. 146—*T. yavorskii* Spizharsky. Permian. *Incertae Sedis.*

Triceratina Upson, 1933, p. 29 (= *Monoceratina* Roth, by Bassler and Kellett, 1934) re-established, by Cooper, 1941, p. 23.

***Tricornina** Bouček, 1936, p. 50—*T. navicula* Bouček. Silurian. ?Acronotellidae (Primitiidae).

Tubulibairdia Swartz, 1936, p. 581—*T. tubulifera* Swartz. Lower Devonian. Bairdiidae.

Uhakiella Öpik, 1937, p. 106—*U. coelodesma* Öpik. Ordovician. Beyrichiidae.

***Ulrichella** Bouček, 1936, p. 73—*U. remesi* Bouček. Silurian. Beecherellidae.

Venula Cooper, 1941, p. 44—*Primitiopsis? striatus* Croneis and Funkhouser. Chester. Glyptopleuridae.

Verrucosella Croneis and Gale, 1938, p. 275—*V. golcondensis* Croneis and Gale = *Cornigella* Warthin, by Cooper, 1941, p. 39.

***Vltavina** Bouček, 1936, p. 47—*V. bohemica* Bouček. Silurian. Acronotellidae. (Primitiidae-Eurychilininae).

Waldronites Coryell[4] and Williamson, 1942, new name for *Cornulina* Coryell and Williamson (not Conrad)—*Cornulina bispinosa* Coryell and Williamson. Niagaran. Aechminidae (Primitiidae).

Warthinia Spivey, 1939, p. 167—*Primitia nodosa* Ulrich. Maquoketa. ?Beyrichiidae (?Drepanellidae).

Whipplella Holland, 1934, p. 343—*W. cuneiformis* Holland. Dunkard. Primitiidae (Aparchitidae by Holland).

[4] Personal communication.

Winchellatia Kay, 1940a, p. 253—*W. longispina* Kay. Decorah. Primitiidae.
Workmanella Croneis and Gale, 1938, p. 277—*W. distincta* Croneis and Gale = *Tetrasacculus* Stewart, by Cooper, 1941, p. 63.
Zygobolboides Spivey, 1939, p. 169—*Z. grafensis* Spivey. Maquoketa. Zygobolbidae.

REFERENCES

BASSLER, R. S., *1941*, Ostracoda from the Devonian (Onondaga) chert of west Tennessee; *Washington Acad. Sci. Jour.*, vol. 31, no. 1, pp. 21–27, 37 figs.

BONNEMA, J. H., *1934*, Über die Aufstellung der Schalen der paläozoischen Ostracoden: *Zeitschr. fur. Geschiebeforschung*, Bd. 10, H. 2, pp. 80–88.

——, *1938*, Zum Aufstellung der Schalen der paläozoischen Ostrakoden und die Brutkammer der weibchen von *Primitiopsis oblonga* J & H: *Natuurh. Maandblad* Jg. 27, no. 10, pp. 104–107, 19 figs.

BOUČEK, B., *1936*, Die Ostracoden des böhmischen Ludlows: *Neues Jahrb., Beil. Bd.* 76, Abt. B, pp. 31–98, pls. 2–6.

——, *1937*, Über Einige Ostrakoden aus der Stufe e_α des böhmischen Silurs: *Soc. Roy Boheme Mem.* for 1936, no. 2, 11 pp., 5 figs.

BRADFIELD, H. H., *1935*, Pennsylvanian Ostracoda of the Ardmore basin, Oklahoma: *Bulls. Am. Paleontology*, vol. 22, no. 73, 145 pp., 13 pls.

BRANSON, CARL C., *1935*, The Sacajawea formation of Wyoming: *Jour. Paleontology*, vol. 11, p. 659. (No figures.)

CHERDYNTSEV, V. A., *1937*, Materials on the microfauna of the Kasanian layers in the Permian system: *Kasan Univ. Sci. Mem.*, T. 97, Kn. 3–4, Geol. No. 8–9, pp. 303–312, 1 pl.

COOPER, CHALMER L., *1941*, Chester ostracodes of Illinois: *Illinois State Geol. Survey Rept. Invest.* 77, 101 pp., 14 pls.

——, *1942*, *Platychilella*, new name for *Platychilus* Cooper: *Jour. Paleontology*, vol. 16, p. 777.

CORYELL, H. N., and CUSKLEY, VIRGINIA A., *1934*, Some new ostracodes from the "White Mound" section of the Haragan shale, Murray Co., Oklahoma: *Am. Mus. Novitates*, no. 748, 12 pp., 2 pls.

——, and JOHNSON, SAMUEL C., *1939*, Ostracoda of the Clore limestone: *Jour. Paleontology*, vol. 13, pp. 214–224, pls. 25–26.

——, and MALKIN, DORIS S., *1936*, Some Hamilton ostracodes from Arkona, Ontario: *Am. Mus. Novitates*, no. 891, 20 pp., 2 pls.

——, and ROZANSKI, GEORGE, *1942*, Microfauna of the Glen Dean limestone: *Jour. Paleontology*, vol. 16, pp. 137–151, pls. 23–24.

——, and SCHENCK, HUBERT G., *1941*, Type of the Ordovician ostracode Genus *Leperditella: Jour. Paleontology*, vol. 15, pp. 176–177, fig. 1.

——, and SOHN, I. G., *1938*, Ostracoda from the Mauch Chunk, Mississippian, of West Virginia: *Jour. Paleontology*, vol. 12, pp. 596–603, pl. 69.

——, and WILLIAMSON, MARJORIE, *1936*, A study of the Ostracoda fauna of the Waldron shale, Flat Rock Creek, St. Paul, Indiana: *Am. Mus. Novitates*, no. 870, 7 pp., 15 figs.

CRONEIS, CAREY, *1939*, Taxonomy of Chester ostracodes: *Denison Univ. Sci. Lab. Bull.*, vol. 34, pp. 28–31.

——, *1942*, *Denisonella*, new name for *Denisonia* Croneis and Bristol (not Krefft): *Jour. Paleontology*, vol. 16, p. 777.

——, and BRISTOL, HUBERT M., *1939*, New ostracodes from the Menard formation; *Denison Univ. Sci. Lab. Bull.*, vol. 34, pp. 65–102, pls. 3–4.

——, and FUNKHOUSER, HAROLD J., *1938*, New ostracodes from the Clore formation: *Denison Univ. Sci. Lab. Bull.*, vol. 33, pp. 331–360, pls. 9–10.

——, and GALE, ARTHUR S., JR., *1938*, New ostracodes from the Golconda formation: *Denison Univ. Sci. Lab. Bull.*, vol. 33, pp. 251–295, pls. 5–6.

——, and GUTKE, RALPH L., *1939*, New ostracodes from the Renault formation: *Denison Univ. Sci. Lab. Bull.*, vol. 34, pp. 33–63, pls. 1–2.

——, and THURMAN, FRANKLIN A., *1938*, New ostracodes from the Kinkaid formation: *Denison Univ. Sci. Lab. Bull.*, vol. 33, pp. 297–330, pls. 7–8.

CULLISON, JAMES S., *1938*, Dutchtown Fauna of Southeastern Missouri: *Jour. Paleontology*, vol. 12, pp. 225–226, pl. 29, figs. 10–12.

FRITZ, MADELEINE A., *1939*, Devonian fossil zones in wells from southwestern Ontario: *Geol. Soc. America Bull.*, vol. 50, no. 1, pp. 79–88. (No figures)

——, *1940*, *Aparchites canadensis*, a new Devonian ostracode from the Onondaga of Ontario: *Jour. Paleontology*, vol. 14, pp. 77–78, pl. 12, figs. 1–3.

GLEBOVSKAYA, E. M., *1936a*, Silurian ostracodes from the northwestern shores of Novaya Zemlya, Russia: *Arctic Inst.*, Tr. v. 58, pp. 33–42, 1 pl.

——, *1936b*, Silurische Ostracoden von USSR: *Akad. Wiss. USSR. Paläozool. Inst., Paläont. USSR.* Bd. 2, T. 1, 96 pp., 26 figs., 8 pls.

——, *1938*, Ostracodes from the Permo-Carboniferous oil-bearing deposits of the Ishimbaev district, Russia: *Petr. Geol.-Prosp. Inst.*, Tr., s. A, no. 101, pp. 177–184, 1 pl.

——, *1939*, Upper Paleozoic Ostracoda from the north Urals: *Petr. Geol.-Prosp. Inst.*, Tr., s. A, no. 115, pp. 165–176, 2 pls.

GOLDRING, WINIFRED, *1935*, Geology of the Berne Quadrangle: *New York State Mus. Bull.* 303, figs. on pp. 80, 91.

GRECO, B., *1935*, La fauna permiana del Sosio conservata nei Musei di Pisa, di Firenze de di Padova; Parte Prima, Introduzione; Considerazioni geopaleontologische; Tunicata?, Crustacea, Cephalopoda: *Paleont, Italica*, vol. 35, pp. 101–190, 4 pls.

GRUBBS, DAVID M., *1939*, Fauna of the Nigaran nodules of the Chicago area: *Jour. Paleontology*, vol. 13, pp. 559–560, pl. 62, figs. 35–39.

HARPER, J. C., *1940*, The Upper Valentian (Silurian) ostracod fauna of Shropshire (England): *Annals Mag. Nat. History* (11), vol. 5, no. 28, pp. 385–400, 1 fig., pls. 9–10.

HARRIS, R. W., and WORREL, FRANK, *1936*, A fossiliferous horizon from the lower Permian of Caddo Co., Oklahoma: *Jour. Paleontology*, vol. 10, pp. 518–519, 7 figs.

HOLLAND, W. C., *1934*, Ostracodes of the Nineveh limestone of Pennsylvania and West Virginia: *Ann. Carnegie Mus.*, vol. 22, pp. 343–350, pl. 25.

JOHNSON, W. R., *1936*, The Ostracoda of the Missouri series in Nebraska: *Nebraska Geol. Survey*, Pap. 11, 52 pp., 5 pls.

KAY, G. MARSHALL, *1934*, Mohawkian Ostracoda; species common to Trenton faunules from the Hull and Decorah formations: *Jour. Paleontology*, vol. 8, pp. 328–343, pls. 44–46.

——, *1940a*, Ordovician Mohawkian Ostracoda; Lower Trenton Decorah fauna: *Jour. Paleontology*, vol. 14, pp. 234–269, pls. 29–34.

——, *1940b*, Decorah Ostracoda, correction: *Jour. Paleontology*, vol. 14, p. 615. (No figures)

——, *1942*, *Dilobella wisconsinensis* Kay, for *D. simplex* Kay: *Jour. Paleontology*, vol. 16, p. 273.

KELLETT, BETTY, *1934*, Ostracodes from the Upper Pennsylvanian and Lower Permian strata of Kansas; 2. The genus *Bairdia: Jour. Paleontology*, vol. 8, pp. 120–138, pls. 14–19.

——, *1935*, Ostracodes of the Upper Pennsylvanian and lower Permian strata of Kansas; 3. Bairdiidae (concl.), Cytherellidae, Cypridinidae, Entomoconchidae, Cytheridae, and Cypridae: *Jour. Paleontology*, vol. 9, pp. 132–166, pls. 16–18.

——, *1936*, Carboniferous ostracodes: *Jour. Paleontology*, vol. 10, pp. 769–784. (No figures)

KUMMEROW, E., *1934*, Nochmals: Die Orientierung der paläozoischen Ostracodenschalen: *Centralbl. Mineralogie* Abt. B, no. 11, pp. 502–505.

——, *1937*, Die Bruteinrichtungen paläozoischer Ostracoden, sowie über *Receptaculites* und einige ordovizische Kalkalgen der Gattung *Apidium*: *Preuss. Geol Landesanstalt Jahrb. 1936*, Bd. 57, H. 1, pp. 465–474, 1 fig., 1 pl.

LALICKER, CECIL G., *1935*, *Cavellina nebrascensis* (Geinitz): *Jour. Paleontology*, vol. 9, pp. 744–745, 7 figs.

LATHAM, MARY H., *1936*, Carboniferous Ostracoda from Inchkeith in: L. M. Davies, Geology of Inchkeith: *Royal Soc. Edinburgh Trans.*, vol. 58, pp. 783–785. (No figures)

MCFARLAN, ARTHUR C., and FREEMAN, LOUISE B., *1935*, Rogers Gap and Fulton Formations in central Kentucky: *Geol. Soc. America Bull.*, vol. 46, p. 2004, pl. 184, figs. 17–23.

MAILLIEUX, E., *1936*, La faune des schistes de Matagne (frasnien superieur): Mus. Roy. Hist. Nat. Belgique, Mem. no. 77, 75 pp., 2 figs., 1 pl.

MAUZ, J. *1933*, Zur Fauna der Unterkoblenz-Stufe: *Senckenberg. naturf. Gesell. Bd.* 15, no. 3–4, pp. 274–294, 24 figs.

MOORE, R. C., WELLER, J. M., and KNIGHT, J. B. *1942*, Erroneous emendation of generic names: *Jour. Paleontology*, vol. 16, pp. 256–257.

MOREY, P. S., *1935a*, Ostracoda from the basal Mississippian sandstone in central Missouri: *Jour. Paleontology*, vol. 9, pp. 316–326, pl. 28.

——, *1935b*, Ostracoda from the Amsden formation of Wyoming: *Jour. Paleontology*, vol. 9, pp. 474–482, pl. 54.

——, *1936*, Ostracoda from the Chouteau formation of Missouri: *Jour. Paleontology*, vol. 10, pp. 114–122, pl. 17.

ÖPIK, A., *1935a*, Ostracoda from the Lower Ordovician *Megalaspis*—limestone of Estonia and Russia: *Tartu Ulikool Geoloogia Instituut*, Toimetused, no. 44, 12 pp., 1 pl.

——, *1935b*, Ostracoda from the Old Red Sandstone at Tartu, Estonia: *Tartu Ulikool Geoloogia Instituut*, Toimetused, no. 45, 8 pp., 1 pl.

——, *1937*, Ostracoda from the Ordovician Uhaku and Kukruse formations of Estonia: *Nat. Soc. Tartu Univ. Ann.*, vol. 43, pp. 65–123, pls. 1–15.

——, *1939*, Brachipoden und Ostrakoden aus dem Expansus-schiefer (Ordovician) Norwegens: *Norsk Geol. Tidssk.* Bd. 19, h. 2–3, pp. 117–142, 3 figs., 6 pls.

PAYNE, KENNETH ARMSTRONG, *1937*, Pennsylvanian Ostracoda from Sullivan Co., Indiana: *Jour. Paleontology*, vol. 11, pp. 276–288, pls. 38–40.

POULSEN, C., *1937*, On the Lower Ordovician Faunas of eastern Greenland: *Meddelelser om Grønland*, vol. 119, no. 3, pp. 59–61, figs. 16–17.

REIN, E. F., *1936*, Paleozoic ostracodes from the northeastern shores of Novaya Zemlya, Russia: *Arctic Inst. Tr.* vol. 58, pp. 45–88, 41 figs. 2 pls.

ROY, SHARAT KUMAR, *1941*, The Upper Ordovician Fauna of Frobischer Bay, Baffin Land: *Geol. Mem. Field Mus. Nat. History*, vol. 2, pp. 169–176, figs. 136–146.

SHROCK, R. R., and RAASCH, G. O., *1937*, Paleontology of the disturbed Ordovician Rocks near Kentland, Indiana: *Am. Midland Naturalist*, vol. 18, pp. 581–583. (No figures)

SCOTT, HAROLD W., *1942*, Ostracodes from the Upper Mississippian of Montana: *Jour. Paleontology*, vol. 16, pp. 152–163, pls. 25–26.

——, and BORGER, HARVEY D., *1941*, Pennsylvanian ostracodes from Lawrence Co., Illinois: *Jour. Paleontology*, vol. 15, pp. 354–358, pls. 49–50.

SHVEIER, A. V., *1940*, Zur Systematik und Klassifikation der fossilen Ostracoden: *Acad. Sci. USSR, C. R.* (Dokl.) vol. 29, no. 2, pp. 172–176, 3 figs.

SOHN, I. G., *1940*, Check List of Mississippian Ostracoda of North America: *Jour. Paleontology*, vol. 14, pp. 154–160. (No figures)

SOLLE, G., *1935*, Die devonischen Ostracoden Spitzbergens. I Leperditiidae: *Skr. Svalb. Ishavet*, no. 64.

——, *1936*, Neu-Benennung von *Holtedahlina* Solle 1935: *Senckenbergiana*, vol. 18, p. 282.

SPIZHARSKY, T. N., *1937*, Ostracoda from the Kolchugino series (Carboniferous) of the coal-

bearing strata of the Kuznetsk basin, Russia: *Centr. Geol. and Prosp. Inst., U. S. S. R., Tr. f.* 97, pp. 139–171, 2 figs., 1 pl.

SPIVEY, R. C., *1939*, Ostracodes from the Maquoketa shale, Upper Ordovician, of Iowa: *Jour. Paleontology*, vol. 13, pp. 163–175, pl. 21.

STEWART, GRACE A., *1936*, Ostracodes of the Silica shale, Middle Devonian, of Ohio: *Jour. Paleontology*, vol. 10, pp. 739–763, pls. 100–102.

——, *1937*, *Aechmina crenulata*, new name for *A. serrata* Stewart (not Coryell and Cuskley): *Jour. Paleontology*, vol. 11, p. 368.

SWARTZ, FRANK MCKIM, *1936*, Revision of the Primitiidae and Beyrichiidae with new Ostracoda from the Lower Devonian of Pennsylvania: *Jour. Paleontology*, vol. 10, pp. 541–586, pls. 78–89.

——, and SWAIN, FREDERICK M., *1941*, Ostracodes of the Middle Devonian Onondaga beds of Central Pennsylvania: *Geol. Soc. Am. Bull.*, vol. 52, pp. 381–458, pls. 1–8.

——, *1942*, *Eustephanella*, new name for *Eustephanus* Swartz and Swain, 1941: *Jour. Paleontology*, vol. 16, p. 674.

TEICHERT, CURT, *1937a*, A new Ordovician fauna from Washington Land, North Greenland: *Meddelelser om Grønland*, vol. 119, no. 1, pp. 43–62, pls. 4–6.

——, 1937*b*, Ordovician and Silurian faunas from Arctic America: *5th Thule Exped. Rept.*, vol. 1, no. 5, pp. 105–120, 150–155, pls. 22–24.

——, *1939*, New names for Ostracode homonyms: *Jour. Paleontology*, vol. 13, p. 622.

THORSLUND, P., *1940*, On the Chasmops series of Jemtland and Södermanland (Tväron): *Sweden, Sveriges Geologiska Undersökning.*, s. C, no. 436 (Årsbok 34, no. 6), pp. 161–182, figs. 57–58, pls. 1–5.

TOLMACHOFF, I. P., *1937*, *Cooperatia*, new name for *Cooperia* Tolmachoff, not Ransom: *Jour. Paleontology*, vol. 11, p. 78.

TURNER, MARY C., *1939*, Middle Devonian Ostracoda from oil wells in southwestern Ontario: *Bulls. Am. Paleontology*, vol. 25, no. 88, pp. 1–32, 1 pl.

TWENHOFEL, W. H., *1937*, Ostracoda in: Geology and Paleontology of the Mingan Islands, Quebec: *Geol. Soc. America Spec. Paper* 11, pp. 65–67, 3 figs.

VOLK, M., *1939*, Das Oberdevon am Schwarzburger Sallel zwischen Südrandspalte und Kamm des Thuringer Waldes: *Phys.-med. Soz. Erlangen, Sber.* Bd. 70, pp. 147–278, 5 figs., 3 pls.

WARTHIN, A. S., JR., *1937*, Type invertebrate fossils of North America: Devonian Beyrichiacea: *Wagner Free Inst. Sci.*, cards 1–105.

WEBER, H., *1934*, Die Eignung der Ostrakoden zu Stratigraphischen Zwecken: *Deutsche geol. Gesell. Zeitschr.* Bd. 86, H. 8, pp. 478–481.

WILSON, CHARLES W., JR., *1933*, Fauna of the McAlester shale, Pennsylvanian, of Muskogee Co., Oklahoma: *Jour. Paleontology*, vol. 7, pp. 412–422, pl. 50, figs. 1–9.

——, *1935*, The ostracode fauna of the Birdsong shale, Helderberg, of western Tennessee: *Jour. Paleontology*, vol. 9, pp. 629–646, pls. 77–78.

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OCCURRENCE AND STRATIGRAPHIC DISTRIBUTION OF PALEOZOIC OSTRACODES[1]

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ABSTRACT.—Although the Ostracoda constitute one of the most persistent orders of microfossils (Lower Ordovician to Recent) they are, considered in detail, quite diversified in character. While many genera are extremely long lived, careful study of formational materials reveals many species that are of value as index fossils. Ostracodes have been found in all types of marine sediments throughout most of the Paleozoic. The differentiation of fresh water forms becomes marked with the initiation of sedimentary conditions which resulted in the rapid alteration of fresh water and marine beds in the sedimentary cycles of the Pennsylvanian and Permian.

INTRODUCTION

SINCE THE segregation of the crustacean "Ostrachoda" as an order by Latreille (1801), these forms have become, next to the Foraminifera, the best known group of microfossils. Study of these fossils during the last 140 years has given us almost 3400 species from the Paleozoic, classified into about 300 genera. The ostracode literature would form a good sized library of about 800 titles. However, more than 50 years were required to produce the first 50 titles, after which a rather steady production of about 10 papers per year was maintained (see fig. 1).

Little progress was made until Jones and his associates Kirkby and Brady began their intensive studies in Great Britain about the middle of the nineteenth century. Their work stimulated others, particularly on the Continent and in North America. Ulrich in 1890, 1891, and 1900 published papers on the "New and little known Paleozoic Ostracoda," and Ulrich and Bassler published their "New American Paleozoic Ostracoda" in 1906 and 1908. In 1923 their "Morphology, Classification and Occurrence" together with the systematic treatment of the Clinton ostracodes of Maryland appeared. This was the most careful and comprehensive stratigraphic treatment based on the ostracodes yet to appear, and it will probably long remain preeminent in this field. Nine zones, each characterized by the prolific and persistent occurrence of an ostracode species, were recognized in this Niagaran formation of western Maryland and adjacent parts of Pennsylvania. Work on ostracodes received further stimulation in this country during the last two decades due to the increasing importance of micropaleontology in petroleum geology. The excellent bibliography of Bassler and Kellett (1934) is indispensable to any worker in Paleozoic ostracodes. Since the publication of this very comprehensive work 167 genera and about 900 species have been proposed in 91 papers (Agnew, 1942).

The systematics of the order has in no manner kept pace with the number of new forms described. Since Latrielle divided the Crustacea into two subclasses and included the Ostracoda under the Entomostraca a number of writers have dealt with the classification of these fossils. In 1850 Baird gave a general description which has served to distinguish the order until today. Dana, in the various editions of his "Manual of Geology" gave a general classification which was rather commonly followed from 1863 to near the end of the century. In 1889, Brady and Norman gave a detailed classification. Bassler (1913) in Zittel's "Textbook of Paleontology" divided the Eucrustacea into five superorders, and the Ostracoda (the third) into nine families. Later Ulrich and Bassler (1923) divided the Ostracoda into 3 superfamilies, 19 families, and 130 genera, several of which are not represented in the Paleozoic. In 1934 (Bassler and Kellett) this number had grown to 18 families and 198 genera for the Paleozoic only, and in the latest compilation the figures show, not counting those eliminated by synonomy, 30 families and 310 genera. Those who have made recent contributions to the classification are

[1] Presented at the conference of the Research Committee on Sedimentation, at the 27th Annual Meeting of the Am. Assoc. Petroleum Geologists, Denver, April 21, 1942.

[2] Illinois State Geological Survey. Published with permission of the Chief.

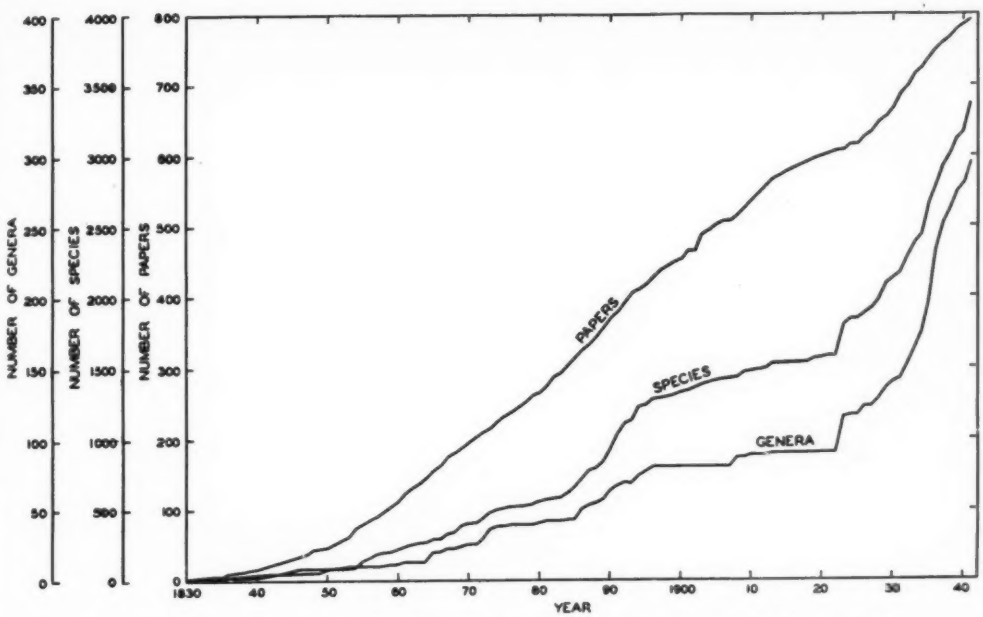

FIG. 1.—Cumulative curves showing rate of production of new genera, species, and papers on Paleozoic ostracodes.

Bouček (1936), Kellett (1936), Swartz (1936), and Teichert (1937).

As in other groups of fossils, we find both "splitters" and "lumpers" among the micropaleontologists and the species concept seems to be just as clouded with differences of opinion as with the zoologists. I do not quite agree with Arkell and Moy-Thomas (1940) that "the question 'what constitutes a species?' hardly concerns the paleontologist." The paleontological classification should be practical in the sense that the "International Rules" should be adhered to meticulously and every new species should conform as nearly as possible to a uniform scale of values. Perfection lies somewhere between the demands of the specialist who endeavors to describe every minute deviation from the norm and the requirements of the teacher or field geologist who must have a simple classification which is easy to use. Although the paleontologist cannot possibly apply the species concept of the biologist to any group of fossils because of the lack of the complete remains of the fossil animal or plant, it is upon species, or even upon the more minute subdivisions as now used by paleontologists that the stratigraphic paleontologist must rely for correlation. If "a species is what a competent systematist considers to be a species" (Croneis, 1939) and that seems to be what a fossil species is today, then it cannot be too strongly urged that the system of classification and of nomenclature be kept as practical and thereby as useful as possible. "The most important question for a worker to ask himself, when erecting genera and species, is why he is doing so. He must remember that he is catering for the specialist and general geologist alike, and that any new addition should aim at clarifying the existing condition, and not obscuring it." (Arkell and Moy-Thomas, 1940). There have been considerable differences of opinion of late regarding the familial affinity of a number of Paleozoic ostracode genera, and the need for a comprehensive study of the superorder as a whole is great.

Sherborn (1897) early recognized the need for the careful collecting necessary for good stratigraphic work when he said "What is really wanted is careful collecting from some well-known section, or series of sections, of any geological formation, and this would be of greater importance than the casual description of various species taken at random

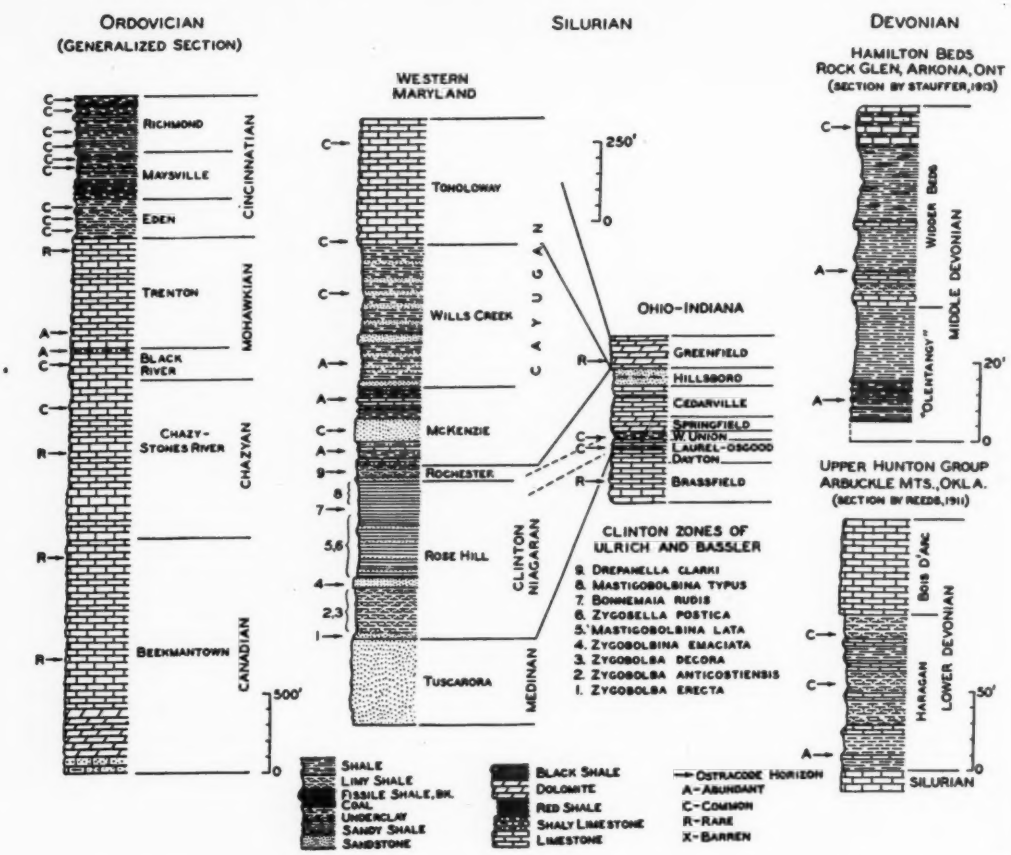

FIG. 2.—Graphic sections of the rock series of the Ordovician, Silurian, and Devonian periods showing the stratigraphic distribution of ostracodes.

from many localities, though the latter is, of course, a very necessary work." This still seems to be a good admonition, and I add my own strong appeal for additional stratigraphic work on some of our less perfectly known horizons, the correlation of which are important to the petroleum geologist. These horizons are found in the Lower Silurian, the Upper Devonian, the Lower and Middle Mississippian, and the uppermost Mississippian (Mauch Chunk). The latter may yield information on the confusing problem of the age of the Stanley-Jackfork series of Oklahoma and Arkansas.

OSTRACODE ENVIRONMENTS

The study of living ostracodes shows their distribution to be world wide and that they seem to be able to thrive under more adverse conditions and are probably less sensitive to rapid changes in environment than most invertebrates. The poor swimmers live in the bottom oozes, some exist in the foul waters of sewers and others in sulphur water and in hot springs. They are also known to be almost unlimited in the depths at which they may exist. Yet ostracodes react to environmental influences, as do other organisms, but, due to their free swimming habit, and due to the scattering action of waves and currents, their carapaces may be found in rocks formed under conditions adverse to the existence of the animal.

Therefore it is not surprising that fossil

ostracodes have been found in a great variety of types of sedimentary rocks, both of fresh water and marine origin.

In the Paleozoic the preponderance of marine over fresh-water species is very great, largely because of the paucity of continental sediments in the stratigraphic column until near the end of the era. There are fewer than a half-dozen Paleozoic fresh-water genera known to me, of which only one genus, from the Dunkard of Pennsylvania and West Virginia, has been published. A number of unpublished new species have been found in the fresh-water members of a few of the Pennsylvanian sedimentary cycles in Illinois.

In marine beds the ostracodes are most easily obtained from the calcareous shales adjacent to, and in the thin shale breaks within limestones, where they occur abundantly. They are usually associated with bryozoans, crinoid fragments, brachiopods, and, in some cases, with conodonts and Foraminifera. Rarely some scolecodonts are found in the washed samples.

Although they are probably as abundant in some limestones as in the adjacent shales, they are very much more difficult to extract and prepare for study. However, thin slabs of limestones often contain great numbers of excellently preserved specimens on their weathered surfaces. This is particularly true of many of those described from the Ordovician and Silurian formations. In many instances the only specimens available must be laboriously prepared from the matrix of the massive limestone but in some cases good specimens can be obtained by careful crushing (not grinding) the limestone in an iron mortar, with frequent sieving. Silicified forms can, of course, be segregated by the use of dilute hydrochloric acid to dissolve the matrix.

Sandstones and sandy or siliceous shales furnish the leanest source of ostracodes. In these rocks the specimens usually occur widely scattered throughout the matrix, and often are found only as moulds or casts, which, except in rare instances, fail to preserve the delicate and intricate surface features which are necessary for accurate identification. These rocks are usually too hard to be broken down by boiling, and the moulds cannot be removed by any known means of separation, except reproduction by one of several methods of artificial casts or squeezes.

STRATIGRAPHIC DISTRIBUTION

True ostracodes are found in rocks of all ages from Lower Ordovician to Recent. Species first described as ostracodes from the Cambrian were later found to belong to the Branchiopoda. The oldest known ostracode species came from the Beekmantown and Chazy rocks of Tennessee, Missouri, Arkansas, Oklahoma and New York.

Ulrich and Bassler (1923) have concisely traced the early history of the class and their conclusions, except for minor details, are still generally accepted in the light of our present knowledge. It is reasonably certain the Ostracoda originated in southern seas during the Early Ordovician by the development of the Leperditiidae from the Cambrian branchiopods. In Middle and Late Ordovician most of the Paleozoic families were introduced, accompanied by a decided shifting to northern seas. This caused a decided change of type, the Leperditiidae, Aparchitidae, and Eurychilininae giving place to the primitive types of the Beyrichiacea of Europe and northern North America. All types, except the Leperditellidae and the widespread genus *Eurychilina*, are rare in the Trenton formations of the Mississippi and Appalachian valleys, and they are almost absent from the succeeding Cincinnatian series. The latter does contain a large number of species similar to those from the late Black River from America north of Missouri and in the Baltic of Europe.

The brood pouches of the females, rarely developed in the Ordovician, become generally developed in the Silurian. Commonly the Beyrichiidae and the Zygobolbidae, all Eurychilininae, and a few Primitiidae, notably *Bolbibollia*, possess brood pouches. The common presence of this feature is a reasonably positive index of Silurian age. Such a pouch is retained in only a few Devonian forms, such as *Treposella* and *Tetrasacculus*.

The Devonian shows marked changes brought about by the almost complete disappearance of the Leperditiidae and by the appearance of new genera of the Beyrichiidae. The new genera *Kirkbya*, *Octonaria*, *Thlipsura*, *Paraparchites*, *Tetrasacculus*,

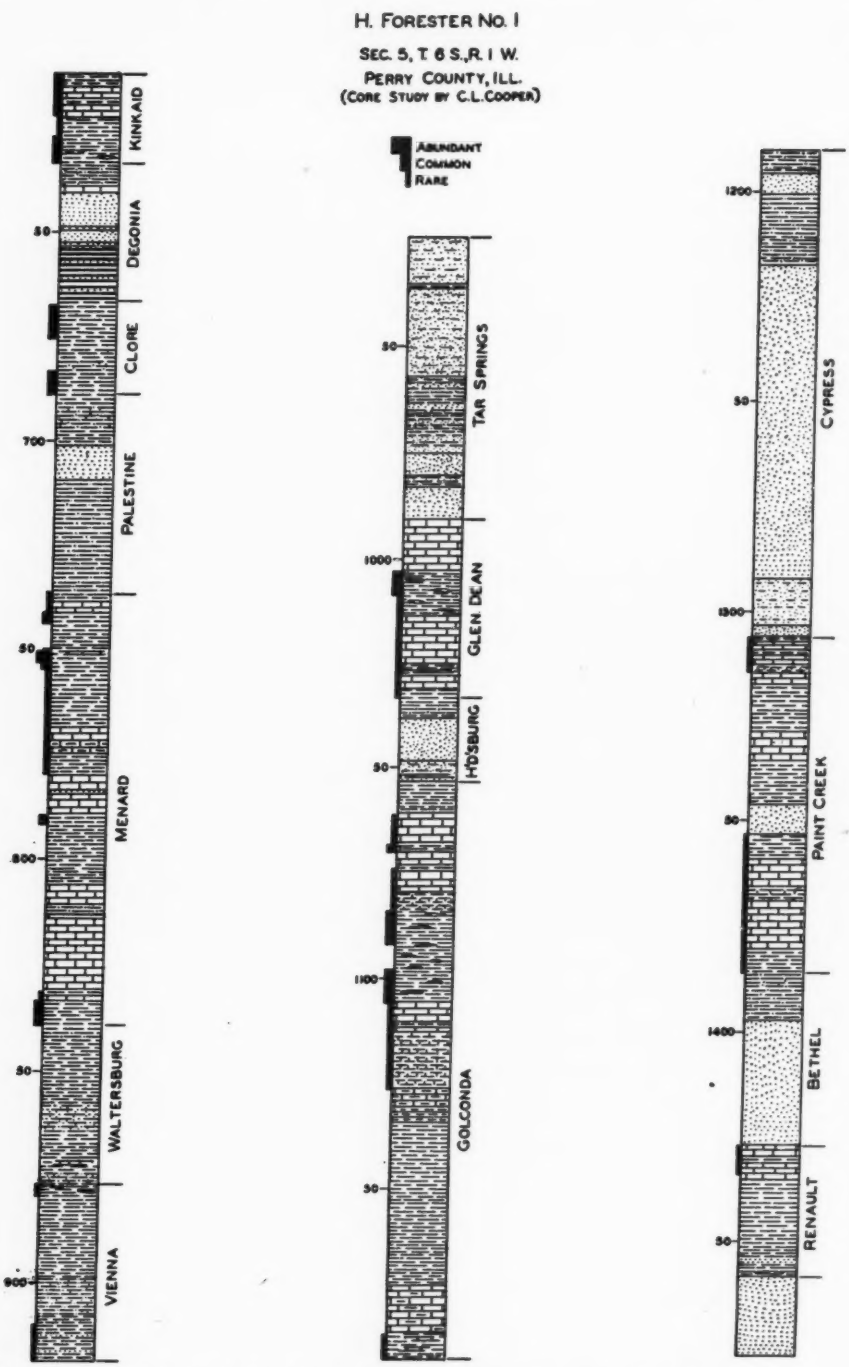

FIG. 3.—Graphic log of a core showing the distribution of ostracodes in the Chester series of Illinois.

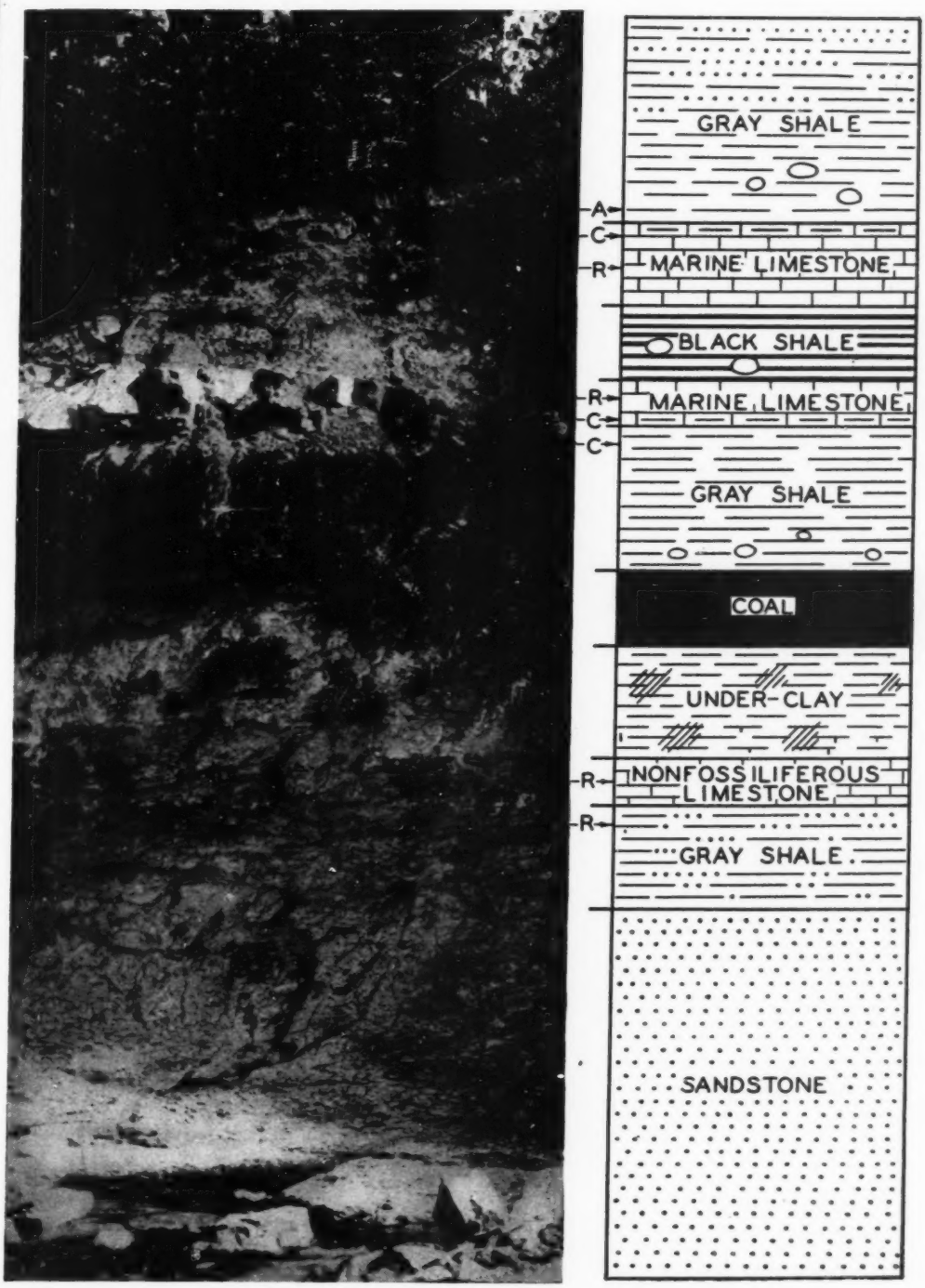

FIG. 4.—Outcrop and diagram of a cyclothem in the McLeansboro of eastern Illinois, illustrating the typical occurrence of ostracodes in the Pennsylvanian.

Cavellina, *Amphissites*, and possibly *Bairdia*, many of which later make important contributions to Carboniferous faunas, make their appearances.

After the Devonian, the whole aspect of the Lower Paleozoic Ostracoda changed so that few of the old familiar ones remain. The *Beyrichia*, *Ctenobolbina*, *Isochilina*, *Leperditia*, and most of the *Primitia* have disappeared. The place of dominance in the Carboniferous is occupied by such genera as *Hollinella*, *Sansabella*, *Jonesina*, *Seminolites*, *Healdia*, *Glyptopleura*, and *Cytherella* (?)[3] in addition to those mentioned above. Many reach their culmination in the Upper Pennsylvanian and carry over into the Permian. A few, such as *Bairdia*, *Pontocypris*, *Bythocypris*, *Macrocypris* and *Cytherella* carry on into the Recent.

The geologic ranges of the Paleozoic ostracode genera are shown graphically in figures 8 and 9.

INDEX OSTRACODES

Ordovician.—As might be expected, the oldest known ostracode horizon, the Beekmantown, contains relatively few species. *Isochilina* dominates the list, with *Leperditia*, *Primitia*, and *Entomidella* following in order. They are rather common in the Stones River of Kentucky and Tennessee, and the Chazy of New York, and they become increasingly abundant throughout the Mohawkian in the Black River of Kentucky and Minnesota, and in the Trenton of Ohio, Kentucky, Tennessee, and New York. The upper Lowville has a fauna of ostracodes which extends from New York to Alabama, thence to the Mississippi Valley States and northward through Canada.[4] The shale-limestone formations of the Cincinnatian have furnished a large number of species, especially in the upper part of the series in the Richmond beds of Ohio and Indiana.

Some Middle Ordovician genera are *Apatochilina*, *Dicranella*, *Hallatia*, *Monoceratina*, *Parabolbina*, *Rayella*, *Saccelatia*, and *Winchellatia*.

[3] The occurrence of this common post-Paleozoic genus in the Carboniferous is questioned because of the close similarity to *Cavellina*, which ranges from the Devonian to the Permian. Future work may show that the Paleozoic species of *Cytherella* should be classified with this genus.

[4] Bassler, R. S., personal communication.

Cincinnatian genera include *Barychilina*, *Biflabellum*, *Jonesella*, and *Milleratia*.

Silurian.—Many of the Ordovician genera continue into the Silurian, some of the persistent types increasing in range and others declining, becoming extinct by the end of the period. The various divisions of the Cayugan, as well as the Rochester shale and its equivalents, can be traced throughout the Appalachian Valley by their ostracode zones.[4]

The Lower Silurian is very poorly defined in ostracode faunas, but the Jupiter River beds of Anticosti are characterized by a number of species of *Zygobolba* in addition to a few species of *Apatobolbina*, *Chilobolbina* and *Leperditia*. Other localities yield numerous species of *Aparchites*, *Beyrichia*, *Bollia*, and *Bythocypris*. *Leperditia* and *Primitia* both showed marked decreases in the Lower Silurian.

The Middle Silurian, the Clinton of Maryland and Pennsylvania is one of the few formations that has been completely zoned by means of these fossils. Ulrich and Bassler (1923) have described nine zones, each characterized by the prolific occurrence of a different ostracode species as shown on figure 2. These zones have been recognized at a number of widely separated localities in New York, Tennessee, Ohio and Indiana.

The Upper Silurian (Cayugan series) contains many horizons with an abundance of ostracodes, particularly in the McKenzie and Wills Creek formations of Maryland and Pennsylvania. Few genera are restricted to the series, although several reach the culmination of their development, with very few species in formations above and below. Some of these are *Dizygopleura*, *Eukloedenella*, *Kloedenella*, and *Zygobeyrichia*.

The development of *Bollia*, *Bythocypris*, *Entomis*, *Kloedenia*, and *Octonaria* continues more or less regularly into the Lower Devonian. *Beyrichia*, *Dizygopleura*, and *Eukloedenella* have few or no representatives after the end of the Silurian. *Leperditia* has reached its peak and declines rapidly in the Devonian.

Devonian.—The rapid decline of many of the characteristic stocks of the Lower Paleozoic at the end of the Silurian reaches completion in the Devonian. At the same time

the introduction of many new genera in the Devonian serves to change the faunal facies almost completely.

The Lower Devonian fauna is made up largely of genera from the Haragan (Helderbergian) of Oklahoma and the Shriver chert (Oriskanian) of West Virginia. Genera which are restricted to or reach their culmination in these formations are *Acanthoscapha*, *Condracypris*, *Kloedenia*, and *Thlipsurella*.

Ostracodes are almost entirely wanting in the Upper Devonian of North America. The complete record includes *Beyrichia dragon*, Geneseo, New York; *Entomis serratostriatus* and *Primitia variostriata*, Naples, New York; and *Kloedenia simplex*, Kings Mill, Pennsylvania. A large number of Upper Devonian species are found in the Eifel, Hartz, Saurland, etc., of Europe and South Devon in Great Britain. Common genera are *En-*

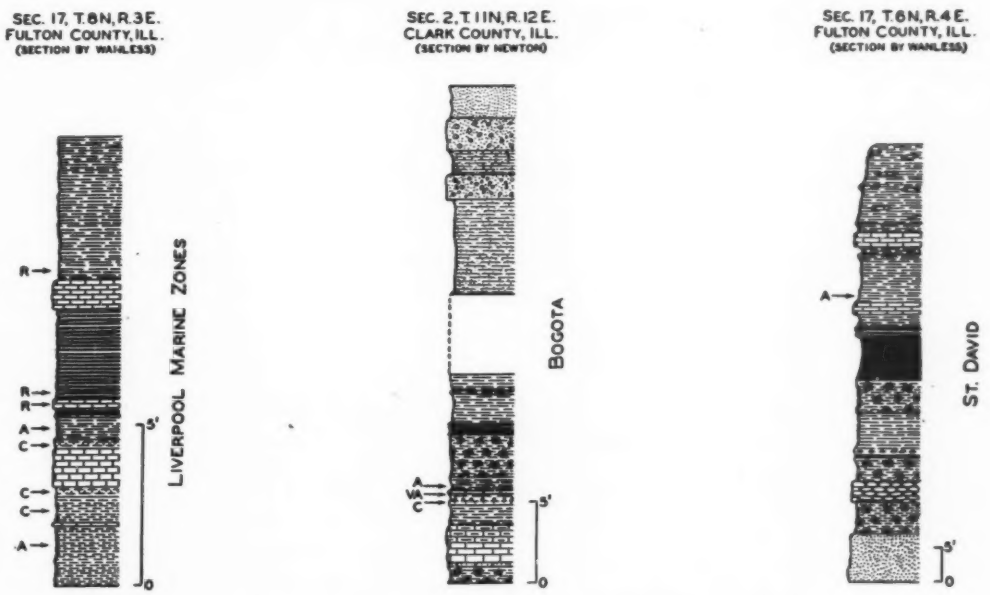

FIG. 5.—Graphic sections of the Liverpool, Bogota, and St. David cyclothems from the Pennsylvanian of Illinois, showing location of ostracode-bearing beds.

The Middle Devonian is best known because of the very excellently preserved material of the Hamilton at Arkona, Ontario, and from species described from the Silica shale of northern Ohio, and the Traverse beds of Michigan. Representative genera are *Barychilina*, *Bufina*, *Burlella*, *Euglyphella*, *Favulella*, *Hamiltonella*, *Hollina*, *Ponderodictya*, and *Quasillites*. Many "firsts" of genera of later importance are recorded, namely *Amphissites* (?),[5] *Bairdia* (?), *Cavellina*, *Hollinella*, and *Kirkbya* (?).

[5] The queries indicate that the genera may have an earlier existence in species of doubtful affinity.

tomis (*Richterina*), *Haploprimitia*, *Nehdentomis*, and *Polycope*.

Bollia, *Ctenobolbina*, *Halliella*, *Haploprimitia*, *Isochilina*, *Kloedenia*, *Leperditia*, *Octonaria*, *Primitia* (?), and *Ulrichia* (?) become extinct during this period.

Mississippian.—Several Devonian genera continue with little change into the Lower Mississippian, chiefly *Bairdia*, *Hollinella*, and *Tetrasacculus*. On the whole the Lower and Middle Mississippian have furnished little in the way of diagnostic ostracodes. Most of the common genera have either come over from the Devonian or are the early representatives of genera common in

the Chester series and the Pennsylvanian system. In the latter category are found *Bairdia*, *Cavellina*,[6] *Glyptopleura*, *Graphiadactyllis*, *Healdia*, and *Paraparchites*.

After a marked decrease in the number of species present in the Lower and Middle Mississippian, an increase is again noted in the Chester series. However, a few of the holdover genera from earlier periods continue their decline, namely, *Beyrichia*, *Entomis*, and *Primitia*. *Amphissites*, *Bythocypris*, *Ectodemites*, *Kirkbya*, and *Paraparchites* continue into the Pennsylvanian with little or no change in the number of species represented. The Chester is characterized by a very great increase in the number of species of *Bairdia*, *Cavellina*, *Glyptopleura*, *Healdia*, and *Paraparchites*. Genera restricted to the series are *Bairdiolites*, *Chesterella*, *Deloia*, *Geffenina*, *Geffenites*, *Glyptopleuroides*, *Lochriella*, *Neokloedenella*, *Paracavellina*, *Perprimitia*, and *Tetratylus*.

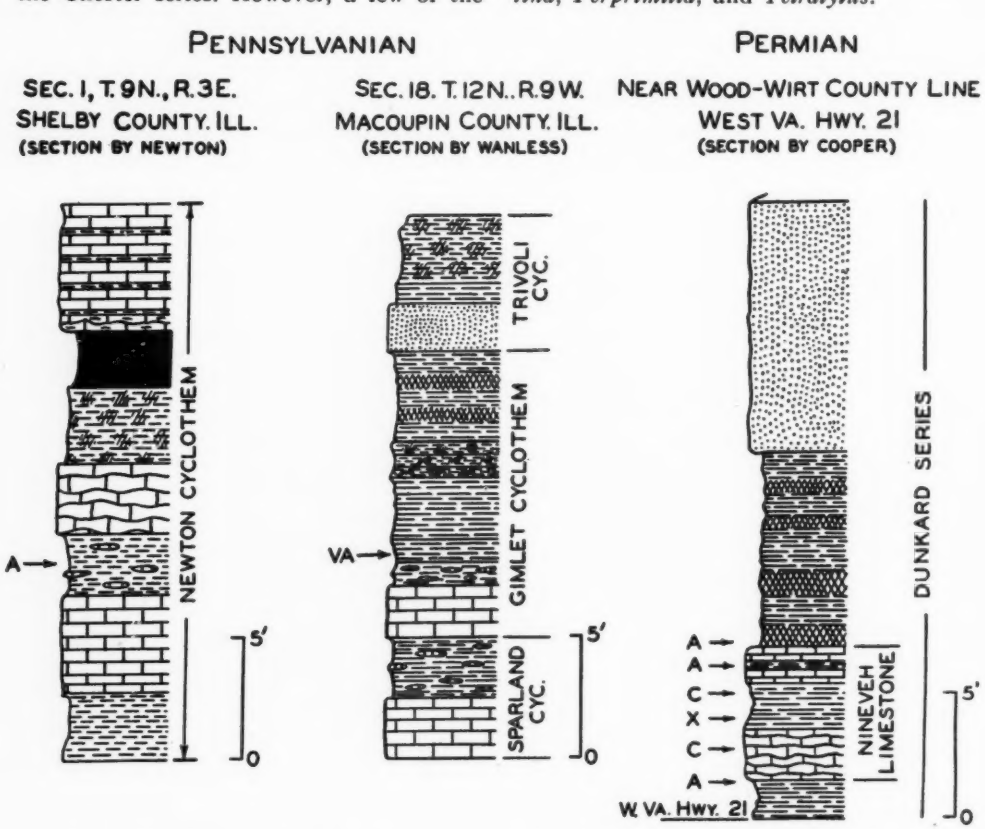

FIG. 6.—Graphic sections of the Newton and Gimlet cyclothems of Illinois and a part of the Permian section of West Virginia showing ostracode horizons.

Pennsylvanian.—The most common ostracodes of this period came over from the Mississippian, and many genera, whose roots were started in the Chester series or earlier, reached culmination in the Middle or Upper Pennsylvanian. In this group we find *Bairdia*, *Healdia*, *Hollinella*, *Kirkbya*, *Knightina*, *Seminolites*, and *Waylandella*. The restricted genera, each represented by

[6] If the Paleozoic cytherellas are equivalent to *Cavellina*, the latter originated long before the Kinderhook, in the Middle Ordovician.

only a few species are *Aechminella* (L, M),[7] *Binodella* (M), *Burlella* (U), *Harltonella* (L), and *Kellettella* (U).

Permian.—Many genera originate in the Pennsylvanian and continue into the Permian, namely, *Bairdianella*, *Basslerella*, *Ellipsella*, *Kelletina*, *Knightina*, *Offa*, and *Roundyella*.[8] Diagnostic Permian genera are *Haworthina*, *Suchonella*, *Suchonellina*, *Tomiella*, and *Whippiella*.[9] All except the first and last are known only from Russia.

REFERENCES

AGNEW, ALLEN F., *1942*, Bibliographic index of new genera and families of Paleozoic Ostracoda since 1934: *Jour. Paleontology*, vol. 16, pp. 756–763.

ARKELL, W. J. and MOY-THOMAS, J. A., *1940*, Paleontology and the taxonomic problem: *The New Systematics*, pp. 395–410, Oxford.

BAIRD, W., *1850*, The natural history of the British Entomostraca, 364 pp., 36 pls.

BASSLER, R. S., *1913*, in Zittel's Textbook of Paleontology, adapted and edited by Chas. R. Eastman, pp. 735–742, figs. 1324–1436, London.

BASSLER, R. S. and KELLETT, BETTY, *1934*, Bibliographic index of Paleozoic Ostracoda: *Geol. Soc. America, Spec. Paper* 1,

BOUČEK, B., *1936*, Die Ostracoden des böhmischen Ludlows: *Neues Jahrb.*, Beilage-Band 76, Abt. B, pp. 31–98.

BRADY, G. S., and NORMAN, A. M., *1889*, *Roy. Soc. Dublin, Trans.*, ser. 2, vol. 4, pp. 61–270.

COOPER, CHALMER L., *1941*, Chester ostracodes of Illinois: *Illinois State Geol. Survey, Rept. Inv.* 77, 101 pp., 14 pl.

CRONEIS, CAREY, 1939, Taxonomy of Chester ostracodes: *Denison Univ., Sci. Lab. Bull.*, vol. 34, p. 32.

DANA, JAMES D., Manual of Geology, editions of 1863, 1866, 1874, 1880, 1895.

KELLETT, BETTY, *1936*, Carboniferous ostracodes: *Jour. Paleontology*, vol. 10, pp. 769–784.

LATRIELLE, *1802*, Histories naturelle generale et particulière des Crustacea, 1801, Paris.

[7] L—Lower, M—Middle, U—Upper Pennsylvanian.

[8] May have a Devonian species, but none is known from the Mississippian.

[9] May be equivalent to *Basslerella*, common in the fresh water beds of the Pennsylvanian of Illinois and the Pennsylvanian and Permian of Kansas.

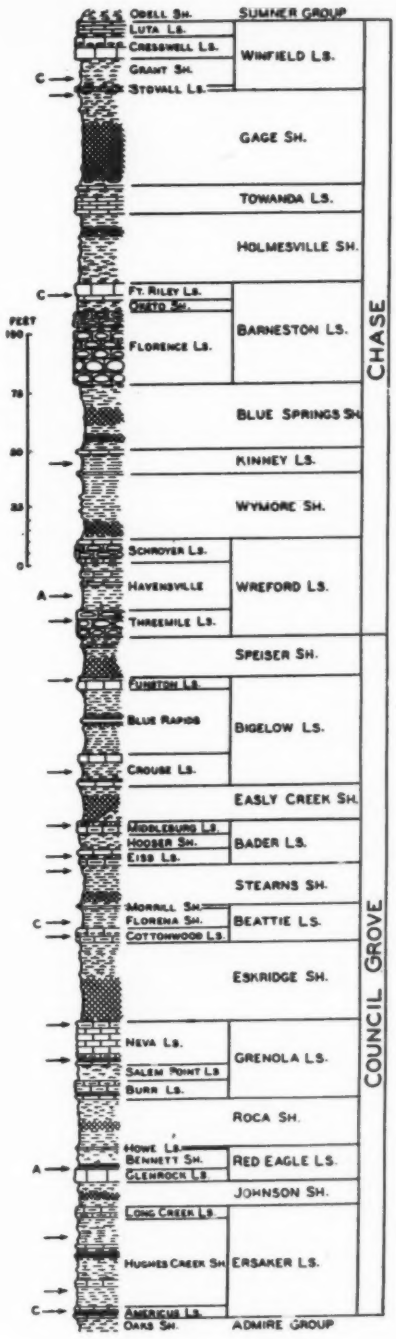

FIG. 7.—Section showing the ostracode horizons in the formations and members of the Chase and Council Grove groups of the Permian of Kansas (Section after Moore, 1936).

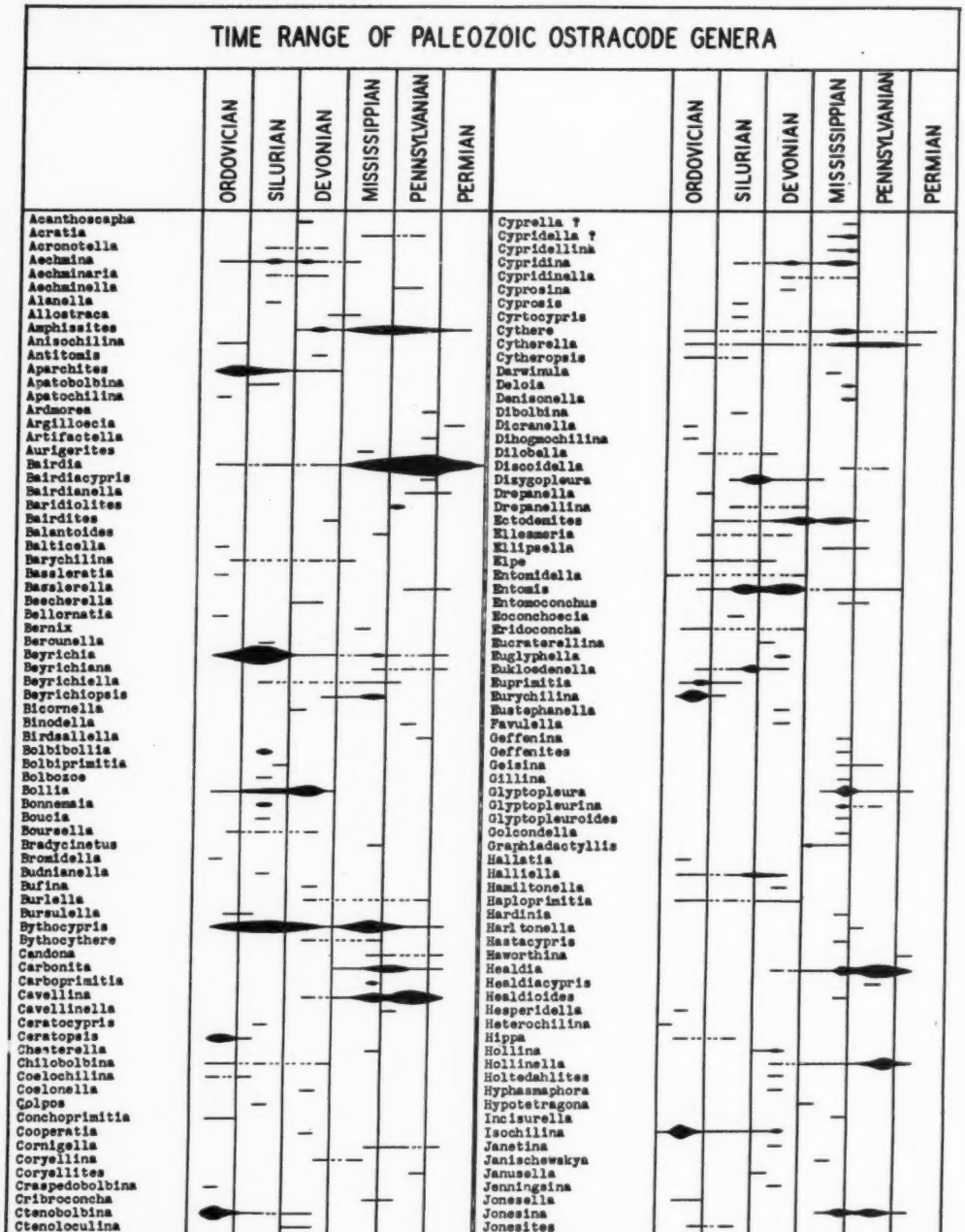

FIG. 8.—Stratigraphic distribution of Paleozoic ostracode genera: *Acanthoscapha*—*Kellettella*. (*Condracypris*, L. Devonian, should be added to the left column).

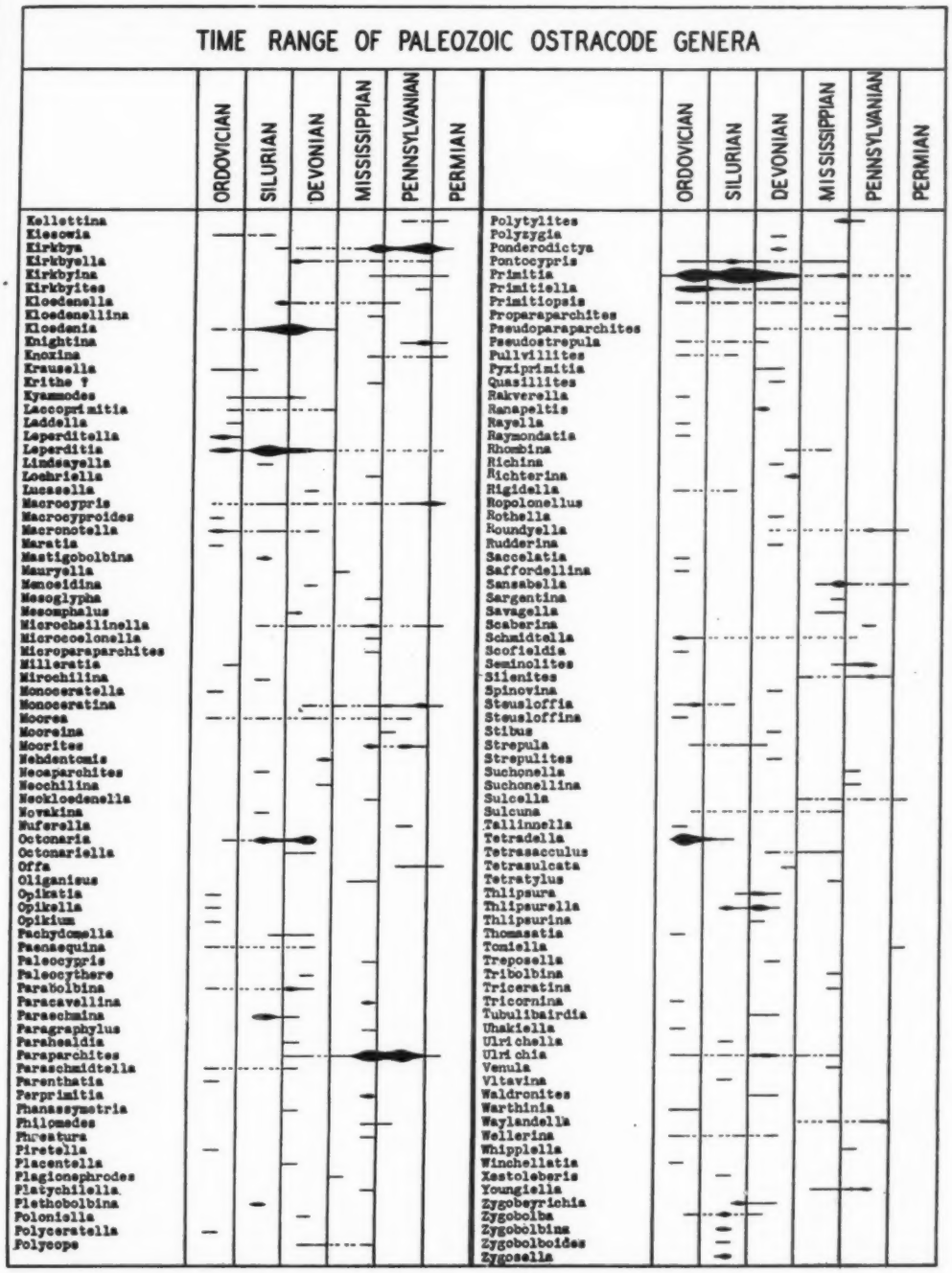

FIG. 9.—Stratigraphic distribution of Paleozoic ostracode genera: *Kellettina—Zygosella.*

MERRETT, EDGAR A., 1924, Fossil Ostracoda and their use in stratigraphical research: *Geol. Mag.*, vol. 61, pp. 228–238.

REEDS, CHESTER A., *1911*, *Am. Jour. Sci.*, Ser. 4, vol. 32, pp. 256–268.

RUEDEMANN, RUDOLF, *1917*, The paleontology of arrested evolution: *New York State Mus. Bull.* no. 196, pp. 107–134.

SHERBORN, C. D., *1897*, The literature of the fossil Ostracoda: *Nat. Sci.*, vol. 10, pp. 181–183, London.

STAUFFER, C. R., *1915*, The Devonian of southwestern Ontario: *Canada Dept. Mines, Mem.* 34, pp. 163–164.

SWARTZ, F. M., *1936*, Revision of the Primitiidae and Beyrichiidae, with new Ostracoda from the Lower Devonian of Pennsylvania: *Jour. Paleontology*, vol. 10. pp. 541–586.

TEICHERT, C., *1937*, A new Ordovician fauna from Washington Land, North Greenland: *Meddelelser om Grønland*, vol. 119, pp. 43–62, pls. 4–6.

ULRICH, E. O., *1890–1891*, New and little known Paleozoic Ostracoda: *Cincinnati Soc. Nat. Hist. Jour.*, vol. 13, pp. 104–137, pp. 173–211, 8 pls.

ULRICH, E. O., *1900*, New American Paleozoic Ostracoda, No. 1, *Ctenobolbina* and *Kirkbya*: *idem.*, vol. 19, pp. 179–186, pl. 8.

ULRICH, E. O. and BASSLER, R. S., *1906*, New American Paleozoic Ostracoda: *U. S. Nat. Mus. Proc.*, vol. 30, pp. 149–164, pl. 11.

ULRICH, E. O. and BASSLER, R. S., *1908*, New American Paleozoic Ostracoda: *idem.*, vol. 35, pp. 277–340, figs. 1–61, pls. 37–44.

ULRICH, E. O. and BASSLER, R. S., *1923*, Maryland Geol. Survey, Silurian volume, 794 pp., 27 figs., 67 pls. American Silurian formations, pp. 233–270. Paleozoic Ostracoda: their morphology, classification and occurrence, pp. 271–391. Systematic paleontology of Silurian deposits (Ostracoda), pp. 500–704, pls. 36–65. Baltimore.

MANUSCRIPT RECEIVED BY THE EDITOR JUNE 27, 1942.

JOURNAL OF PALEONTOLOGY, VOL. 16, NO. 6, PP. 777–780, NOVEMBER, 1942

PALEONTOLOGICAL NOTES

PLATYCHILELLA, NEW NAME FOR PLATYCHILUS COOPER

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During the compilation of an index of Paleozoic ostracode genera by Allen Agnew under my direction, it was discovered that *Platychilus* Cooper, 1941 (Illinois State Geol. Survey, Report of Investigations, 77, p. 38, pl. 6, figs. 26, 27) was preoccupied by *Platychilus* Jakolev, 1874 (Bull. Soc. Imp. Nat. Moscou, vol. 48 (1), p. 256). The new name *Platychilella* is proposed to replace this homonym.

DENISONELLA, NEW NAME FOR DENISONIA

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Mr. Allen F. Agnew of the Illinois Geological Survey has kindly called our attention to the fact that the name *Denisonia*, which we proposed (p. 76, vol. 34, Denison University Bull., Jour. Sci. Lab., 1939) for a Menard (Chester) ostracode is a junior homonym of *Denisonia* Kreft, an Australian snake (Kreft, Gerard, pp. 318–322, Proc. Zool. Soc. London, 1869). The writers therefore propose the new name *Denisonella* for the Mississippian ostracode with *Denisonella cincta* (Croneis and Bristol) the holotype. Other species of the genus are *D. brevicosta* and *D. cirrata* (Cooper) from the Golconda formation (Cooper, C. L., pp. 54–55, Illinois Geol. Survey Report of Investigations, No. 77, 1941).

MARGINICINCTUS VERSUS WORTHENELLA

A. H. SUTTON

In a recent issue of this Journal (vol. 16, no. 4, p. 464, July 1942) I recommended that the name *Marginicinctus* Sutton be suppressed as a synonym of *Worthenella* Girty. Dr. G. Arthur Cooper of the United States National Museum has kindly called to my attention the fact that C. D. Walcott (Smithsonian Misc. Coll. 57, no. 5, p. 125, 1911) had previously used the name *Worthenella*. This earlier usage of the name renders it unavailable as proposed by Dr. Girty and means that *Marginicinctus* is therefore the valid generic name for the group of productids for which it was proposed (Sutton, Jour. Paleontology, vol. 12, no. 6, p. 561, 1938).

THE STATUS OF SUPPOSED FOSSIL CIRRATULIDS FROM THE PACIFIC COAST

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Irregular masses of bleached calcareous tubes of cirratulids are frequently seen along the West Coast beaches and often are included in collections of fossil invertebrates. The belief that they represent ancient types dates from 1909, when Dall[1] described a well preserved specimen from Coos Bay, Oregon as *Serpula? octoforis*. The type, now in the National Museum, was obtained by him through purchase from B. H. Camman, along with undoubted fossils from the Empire formation, then considered of Late Miocene age.

Many years later Howell and Mason[2] reported the discovery of similar masses of worm tubes from Deadman Island, southern California, which were attributed to the San Pedro stage of the Pleistocene. Those authors published figures of the holotype and paratype of their new species "*Serpula*" *saxistructoris*, but unfortunately they did not describe it or give any detailed account of its actual occurrence.

An examination of the figures of these two supposed fossil species indicates that they are apparently identical as far as can be judged from the calcareous tubes.

The writer has collected similar worm tubes at many localities along the Oregon beaches between Cape Blanco and Cape Fairweather. Within this stretch of the Oregon coast several fossiliferous formations are exposed in cliff section, representing much of the Tertiary time. Although no specimens ever have been found in place, the writer, following Dall has assumed that they represented a long ranging fossil species.

Further evidence of the occurrence of these worm tubes resulted from a visit to the oceanographic boat, the Catalyst, that put into Coos Bay in 1939 after dredging along the Oregon Coast. Among the specimens then exhibited by Dr. Thomas Thompson were masses of calcareous colonial worm tubes dredged off Seal Rocks just south of Newport, in 14–17 fathoms of water. The similarity of those masses with the supposed fossil from the Empire formation was immediately recognized and further study indicates that the tubes of the modern species do not differ in form and habit of growth from the specimen described by Dall.

A few of those modern specimens, presented at that time to the writer, were recently referred to Miss Olga Hartman of the Allan Hancock Foundation, University of Southern California, for identification. They proved to belong to the Cirratulidae, and have been described as *Dodecaceria fistulicola* Ehlers (*? = Sabella pacifica* Fewkes[3]). That species occurs along the west coast of North America and at Iquique, Chile. In southern California this worm is intertidal, although as yet it has not been found in that zone near Coos Head, Oregon.

Since this cirratulid is frequently collected along the West Coast beaches, and, as far as the writer is aware, has never been found embedded in Tertiary sediments, it appears probable that Dall's species was based on a modern specimen. If it actually was found in Pleistocene deposits, it should be referred to the modern species, since specific distinctions among those chaetopods are based only upon soft parts. It will be of interest to reexamine the evidence for the occurrence of *D. fistulicola* in Pleistocene deposits and watch for even an earlier appearance in Tertiary beds of this west coastal region.

[1] Dall, Wm. H. The Miocene of Astoria and Coos Bay. *U. S. Geol. Survey* Prof. paper, 59, p. 138. pl. 20, 1909.

[2] Howell, B. F. and Mason, John F. Reef-forming serpulid from the Pleistocene of California. *Bull Wagner Free Inst. Sci.*, vol. 12, no. 1, pp. 1–2, figs. 1 and 2, 1937.

[3] Fewkes, J. W. New Invertebrate from the Pacific Coast of California. *Bull. Essex Institute*, vol. 21, pp. 99–146, 7 pls., 1889.

RENAMING PRIMARY HOMONYMS AFTER GENERIC REALLOCATION[1]

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STATEMENT OF THE PROBLEM.— Should a primary homonym be renamed if either of the species involved is transferred to another genus? The problem, in other words, is: *X-us albus* Doe, 1840, is a primary homonym of *X-us albus* Smith, 1837, but the species of Doe was transferred to the genus *Y-us* by Brown in 1925 and has since been known as *Y-us albus* (Doe), 1840. Must a systematist who discovers in 1941 that *X-us albus* Doe was a primary homonym rename the species despite the generic reallocation?

From among many examples that might be cited the following are selected:

EXAMPLE OF NUCULA PHILLIPSII.—F. von Hagenow described *Nucula phillipsii* in 1842 (p. 561) from the Cretaceous of Europe. In 1850 (p. 318) J. Morris described as new *Nucula* (*Leda*) *phillipsii* from the Jurassic of England. The latter is thus a primary homonym. According to the International Rules of Zoölogical Nomenclature, Morris' species was "stillborn" and should be renamed, no matter whether it has been transferred to another genus or not. This action was not taken by Cox (1937), who transferred the Jurassic species to another genus, making the name-combination *Palaeoneilo phillipsii* (Morris).

EXAMPLE OF NUCULA ABRUPTA.—J. D. Dana in 1847 (p. 147) described as a new species *Nucula abrupta* from beds of probable Paleozoic age at Illawarra, Australia. T. A. Conrad, 1848 (p. 432), described from the Tertiary of Astoria, Oregon, another species under the same name, *Nucula abrupta*. Conrad in 1852 (p. 232) described as a new species from Syria yet a different shell under the name *Nucula abrupta*. In 1865 Conrad (p. 153) listed the species from Oregon as *Neilo abrupta*, and Dall (1909, p. 106) referred to it as *Malletia abrupta*.

[1] Abstract published in *Bull. Geol. Soc. of America*, vol. 52, no. 12, pt. 2 (Dec., 1941), p. 1938.

According to the International Rules, Conrad's *Nucula abrupta* based on the specimens from Astoria, Oregon, must be renamed; this is true also for the name based on material from Syria.

POSSIBLE SOLUTION. — The course of action to follow according to the Rules at present is to rename a primary homonym, no matter whether one or both of the species has been transferred to another genus. If workers object to this—as in practice they appear to do—they might appeal to the International Commission on Zoölogical Nomenclature, requesting a ruling that if reallocation has been proposed before the homonymy is discovered the homonym need not be renamed. But what are the chances that such an appeal would receive attention and that an opinion would be rendered, especially in time of war?

We propose, therefore, that each professional society in the United States and Canada concerned with taxonomy select a member for a Committee on Zoölogical Nomenclature; that the committee thus constituted elect a chairman; that cases needing action be submitted in writing to the committee; and that cases which cannot be settled by this committee be submitted to the International Commission when and if it again functions.

REFERENCES

CONRAD, T. A. *1848*, Fossil shells from Tertiary deposits on the Columbia River, near Astoria: *Am. Jour. Sci.*, ser. 2, vol. 5, pp. 432–433.

——, *1852*, Description of fossils of Syria: *in* Wm. F. Lynch, *U. S. Expedition to explore the Dead Sea and River Jordan:* U. S. Navy Dept., Washington: pp. 211–235.

——, *1865*, Catalogue of the older Eocene shells of Oregon: *Am. Jour. Conch.*, vol. 1, no. 2, pp. 150–154.

COX, L. R., *1937*, Notes on Jurassic Lamellibranchia. I. On the occurrence of the genus *Palaeoneilo* in the Jurassic of Great Britain: *Proc. Malac. Soc.*, vol. 22, pt. 4, pp. 190–193.

DALL, W. H., *1909*, Contributions to the Tertiary paleontology of the Pacific Coast. I. Miocene of Astoria and Coos Bay, Oregon: *U. S. Geol. Survey Prof.* Paper 59, 278 pp., 23 pls.

DANA, J. D., *1847*, Descriptions of fossil shells of the collections of the Exploring Expedition under the command of Charles Wilkes, U. S. N., obtained in Australia from the lower layer of the coal formation: *Amer. Jour. Sci.*, ser. 2, vol. 4, pp. 151–160.

HAGENOW, FRIEDR. VON, *1842*, Monographie der *Rügen'schen* Kreide-Versteinerungen, III. Abtheilung: Mollusken: *Neues Jahrb.*, pp. 528–575.

MORRIS, JOHN, *1850*, List of organic remains obtained by Reginald N. Mantell, Esq., from the railway cuttings above described: *Quart. Jour. Geol. Soc. London*, vol. 6, pp. 315–319.

CATALOG OF IMPORTANT PALEOZOIC INVERTEBRATE COLLECTIONS

A catalog is planned to list the present locations of important Paleozoic invertebrate collections, particularly those made prior to 1900 and containing type specimens. The undersigned will appreciate any information that would aid in completing this undertaking.

The information requested includes principally the name of the collection, general scope, present institutional guardianship, and pertinent historical facts. Data regarding collections lost or destroyed is likewise earnestly desired.

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JOURNAL OF PALEONTOLOGY, VOL. 16, NO. 6. PP. 781–784, 1 TEXT FIG., NOVEMBER, 1942

REVIEW

ÜBER DIE TERTIÄREN ORBITOIDIDEN UND DIE MIOGYPSINIDEN VON NORDWESTMAROKKO, by P. Brönnimann, Schweizerische Palaeontologische Abhandlungen, Bd. 63, 113 pp., 11 double plates, 37 figures in text, 2 tables, Basel, 1940.

This important monograph is based on specimens collected by Alfred Senn in northwestern Morocco from beds of late Eocene, Oligocene and Miocene (Burdigalian) age. From the stratigraphic sections were obtained 80 collections which yielded hundreds of isolated individuals. Detailed observations were made on 700 well oriented thin sections. The dimensions of many individuals are given in both tabular form and in scatter diagrams.

The author studied especially the internal structures of the fossils in order to determine ontogenetic stages of the species. The comparative morphology of the "larger" Foraminifera indicates that the characteristics of the central inner structures, being amenable to statistical treatment, allow an objective differentiation of the morphologic types, particularly when weighted against the external characters. Coordination between inner and outer structural characteristics of the shell, however, cannot yet be made satisfactorily for all species. More attention must be paid to the external features of a test, especially microspheric forms, which at present are often not considered in morphogenetic studies. Contour of the test, arrangement and diameter of the pillars, size of the umbilical area, relation of the umbo to the margin of the test, and nature and formation of flanges are some of the significant features. Twenty years ago H. Douvillé pointed out that for identification of species the external features are of more value than the inner structure. Recently J. Flandrin said that an exact specific determination based on thin sections alone is impossible. As in all organisms, proper identification must be founded on a summation of characters.

The stratigraphic distribution of the species is given in the accompanying condensed distribution chart, Table I. Attention is directed to the fact that *Lepidocyclina, sensu stricto*, was found in this area only in beds of Eocene age. No specimens of *Nephrolepidina* and *Eulepidina* were recognized in Eocene rocks. The coexistence of *Asterocyclina*, *Discocyclina*, and *Lepidocyclina* is emphasized by the author. No evidence is adduced, other than the larger foraminifers, to prove that the ages (Ledian, Wemmelian, Sannoisian, etc.) are correctly applied to the strata in Morocco. The measured sections shown in the geologic columns are in separate localities; in no one is the entire column represented.

Most of the monograph is devoted to detailed descriptions of the species. As considerable emphasis in these is placed on the embryonic parts of the tests, we reproduce here with slightly modified and translated labels the author's text figure 3.

It may be remarked that none of the fine photomicrographs in the monograph shows the supposed stolon canals between the protoconch and deuteroconch. Only a few of the other stolons can be seen in the illustrations. Consequently, it would seem that further study needs to be given to the detailed structure of the embryonic apparatus (= nucleoconch = nepiont = juvenarium) before accepting the universal application of this schematic representation to the detailed morphology of these foraminifers.

Particularly noteworthy is the discussion of *Lepidocyclina mauretanica*, where Brönnimann (p. 38) deals with the stolons connecting the equatorial chambers. As a rule, the four-stolon system is present, but towards the periphery of the tests he recognized six stolons. The author points out (p. 35) that the central, arcuate chambers communicate through four stolons, whereas the peripheral, spatulate ones through six stolons. This observation is of exceptional significance in view of the taxonomic importance attached to the stolons by Van de Geyn and Van der Vlerk in 1935.

Another noteworthy contribution of this monograph is his discussion and illustration of the variations of the nucleoconch of the several species, especially *Lepidocyclina* (*Nephrolepidina*) *tournoueri* (Lemoine and R.

TABLE I.—CONDENSED DISTRIBUTION CHART FROM BRÖNNIMANN, P. 104

Species	Upper Eocene[1]	Oligocene[2]	Miocene[3]
Miogypsina irregularis (Michelotti)		×[4]	×
M. mediterranea Brönnimann			×
M. mediterranea var. *excentrica* Brönnimann			×
M. basraensis Brönnimann		×	×
Miolepidocyclina burdigalensis (Gümbel)			×
Miogypsinoides complanata (Schlumb.) var. *mauretanica* Brönnimann		×[4]	×?
M. aff. *dehaarti* (Van der Vlerk)		×	
Lepidocyclina (*T.*) *renzi* (David)		×	
Lep. (*E.*) cf. *elephantina* (Munier-Chalmas)		×	
Lep. (*E.*) *dilatata* (Michelotti)		×	
Lep. (*N.*) *marginata* (Michelotti)		×	
Lep. (*N.*) *marginata* (Michelotti) var. *cottreaui* (R. Douvillé)		×	
Lep. (*N.*) *partita* (H. Douvillé)		×	
Lep. (*N.*) *tournoueri* (Lemoine & R. Douvillé)		×	
Lep. (*N.*) *tournoueri* (Lem. & R. Douv.) var. *praetournoueri* (H. Douvillé)		×	
Lep. (*I.*) *mauretanica* (Bourcart & David)	×		
Lep. (*I.*) *mauretanica* (Bourcart & David) var. *minor* Brönnimann	×		
Lep. (*I.*) *sarsarica* Brönnimann	×		
Discocyclina strophiolata (Gümb.)	×		
D. sella (d'Archiac)	×		
D. pratti (Michelin)	×		
D. nummulitica Gümbel	×		
Asterocyclina stella Gümbel	×		
A. aff. *stellata* (d'Arch.)	×		
A. praestellaris Brönnimann	×		
A. stellaris (Brunner)	×		

[1] Stages of Upper Eocene are Ledian and Wemmelian.
[2] Stages of the Oligocene are Sannoisian, Rupelian, Chattian, and Aquitanian.
[3] Lower Miocene is Burdigalian.
[4] The lowest record of *Miogypsina* is in strata of Chattian age, of *Miogypsinoides* in Chattian, questionably in Rupelian.

Douvillé). For the lepidocyclines in general Brönnimann believes that the best subgeneric criterion is the form of the embryonic apparatus. Next in importance is the arrangement of the periembryonic chambers. For example, the "isolepidine" types in the Eocene species of *Lepidocyclina* lack accessory auxiliary chambers, whereas they are present in the nephrolepidine and "isolepidine" forms of the Oligocene.

In *Discocyclina s.l.*, especially in the upper Eocene species of *Asterocyclina*, an analysis of the periembryonic chambers shows that their number during ontogeny is inconstant, varying between 24 and 11. The nucleoconch, however, is constant, being invariably of the reniform type. Constancy is also manifested in the size of the main auxiliary chambers. It was not possible to recognize in *Asterocyclina* any character which would have permitted further subdivision of the genus into such characteristic forms as in other larger Foraminifera. Tan's principle of acceleration of the nepionic phase in the larger Foraminifera is shown by the reduction of the numbers of the periembryonic chambers in *Asterocyclina* during their evolution.

Brönnimann agrees with Tan and Barker and Grimsdale in detaching the family *Miogypsinidae* from the family *Orbitoididae*. Important morphologic criteria in *Miogypsina* and its allies are the lateral chambers and the arrangement of the embryonic apparatus within the layers of the equatorial chambers. With these two criteria it is possible to recognize the following: *Miogypsinoides* Yabe and Hanzawa, *Conomiogypsinoides* Tan, *Miogypsina* Sacco, *sensu stricto*, and *Miolepidocyclina* Silvestri. Tan recog-

nized five types of embryonic spiral arrangement in *Miogypsina s.l.* These are the *complanata* type (embryonal spiral with 1¼ to 2 and more convulutions), the *borneensis*-type (embryonic spiral with only one convolution), the *ecuadoriensis*-type (only one main auxiliary chamber from which two spirals originate), the *indonesiensis*-type (two spirals arise from each of two equal-sized main auxiliary chambers), and the *bifida*-type (from two unequal-sized main auxiliary chambers two spirals each are formed), which are accepted by Brönnimann for the miogypsinid material of Morocco. However, in Morocco the *indonesiensis*-type appears stratigraphically later than the *bifida*-type and phylogenetically is the highest developed type in *Miogypsina, s.l.* Of the five types mentioned, only the *borneensis*-type is missing in Morocco.

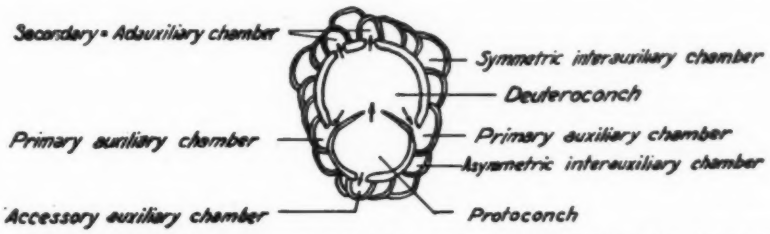

FIG. *1*—Schematic diagram of the embryonic apparatus and periembryonic equatorial chambers of the higher orbitoids and miogypsinids, modified from Brönnimann (1940, fig. 3). The arrows show the stolons between the chambers.

An excellent account of the structural characteristics of *Miogypsina, s.l.* is given. Scatter diagrams show the size-relation (diameter and thickness), the types of the embryonic apparatus are described, the form of the equatorial and lateral chambers is discussed, the stolon system is examined, and notes are given on the intraseptal and intramural lumina.

Regarding the stolon system in *Miogypsina, s.l.*, the author differentiates a simple stolon system (*Miogypsinoides*-stolon system of Tan), a double stolon-system (*borneensis*-stolon system of Tan), and a triple stolon system (*mediterranea*-stolon system of Brönnimann). The triple stolon system consists of the ontogenetically-late equatorial chambers of *Miogypsina mediterranea* var. *excentrica* of 3 stolons: the normal (basal), the proximal and distal stolons of the double-stolon system (in which the one pierces the wall of the chamber proximally, the other distally), and of a third one, which is intercalated between the normal and the proximal-distal ones and is not in the same axial plane.

In northwest Morocco, the stratigraphically lowest member of the Miogypsinidae is a form of *Miogypsinoides* which seems to be more primitive than *Miogypsinoides complanata* var. *mauretanica*. The stratigraphically highest representative is *Miogypsina mediterranea* var. *excentrica*. The fact that miogypsinids of the *bifida*- and *indonesiensis*-type occur in Morocco contradicts Tan's statement that such types might possibly be absent in the Mediterranean province. In this province, the miogypsinids show the same orthogenetic evolution as was established previously by Tan for the East-Indian province, thus permitting a correlation of the miogypsinid-bearing sediments in northwestern Morocco with those in Central America and the Dutch East Indies.

Brönnimann correctly credits Tan, 1936, with the authorship of the family name Miogypsinidae. The subfamily name Miogypsininae dates from Vaughan, 1928. It would aid in an understanding of the phylogeny of these foraminifers if the genus *Miolepidocyclina* Silvestri, 1907, and perhaps others, were grouped in a new subfamily, for those forms having central rather than excentric nucleoconchs.

The author uses the subgeneric name *Isolepidina* for species belonging to the restricted subgenus of *Lepidocyclina*. This practice is contrary to the International Rules of Zoölogical Nomenclature. Article 9 is as follows:

"If a genus is divided into subgenera, the name of the typical subgenus must be the same as the name of the genus."

Brönnimann is not alone in his misunderstanding of this article. Schenck and Frizzell (Am. Jour. Sci., vol. 31, pp. 464–466) have pointed out a similar malpractice on the part of A. E. van de Geyn and I. M. van der Vlerk.

Less clear is the application of the Rules to the names of varieties. As we read them, the Rules mention species and subspecies, but not varieties. We can find neither in the Rules nor in the Opinions any reason for believing that varieties have any nomenclatural standing in the eyes of the law. Thus, under the code it is not necessary to rename the two homonyms: *Lepidocyclina mauretanica* var. *minor* Brönnimann (NOT Rutten, 1911) and *Miogypsina mediterranea* var. *excentrica* Brönnimann (NOT Tan, 1937). Suppose, however, a subsequent author elevates Brönnimann's two varieties to specific rank? The Rules would then apply. Hence, it is unfortunate that the author did not employ more ingenuity in coining varietal names.

It may be remarked, in passing, that many systematists in other fields than paleontology regard varietal and subspecific names as nomenclaturally the same. Several such workers admit that they have no precedent for this stand under the Code. A ruling by the Commission is in order, but until an opinion is rendered we recommend strict adherence to Article XI, which provides that "specific and subspecific names are subject to the same rules and recommendations, and from a nomenclatural standpoint they are co-ordinate, that is, they are of the same value." Since varieties are not now nomenclaturally valid, we believe that systematists might well do without them or so name biological entities that no confusion can arise.

Such a detailed investigation as this by Brönnimann cannot fail to call attention of specialists to the unsatisfactory classification and phylogeny of the larger Foraminifera. A few students have emphasized the importance of the stolon system in classification, but they have derived a four-stolon foraminifer from a six-stolon ancestor. Brönnimann shows that the number of stolons varies with the age of the individual, thus proving that such a derivation cannot hold. Another worker has held that a spiral nucleoconch is more primitive than a bilocular one, yet he has derived a genus with a spiral nucleoconch from a bilocular ancestor. Such inconsistencies have made several investigators realize that the present classification of a large number of the orbitoids and their allies is subject to improvement. Although Rutten (Geologie en Mijnbouw, 1941) took steps to correct some of the mistaken arrangements, it may be that a more radical revision of the larger foraminifers is necessary in order to revolutionize the thoughts of the specialists.

HUBERT G. SCHENCK, Stanford University, and HANS E. THALMANN, Guayaquil, Ecuador.

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ERRATA

Murray, Grover Jr., and Keith M. Hussey, Some Tertiary Ostracoda of the genera *Alatacythere* and *Brachycythere*, Jour. Paleontology vol. 16, pp. 164–182, pls. 27, 28, text figs. 1, 2.

p. 169 In the acknowledgments "Dr. J. A. Alexander, ———" should read Dr. C. I. Alexander, ——.

p. 166 In the explanation to text figure 1 the last line should read: 3–6. *Alatacythere lemnicata* (Alexander)

Hypotype slide no. 2727. 3, X 4e, dorsal outline of ———

Teichert, C., Permian Ammonoids from Western Australia, Jour. Paleontology, vol. 16, pp. 221–232, pl. 35, text figs. 1–7.

In the explanation of text-fig. 4A read 1.65 instead of 2.5; in 4B read 2.65 instead of 4; in 6A read 1.8 instead of 4.5; in 6B read 0.4 instead of 1; in 6C read 1 instead of 2.5; in 6D read 1 instead of 2.5; in 6E read 0.4 instead of 1; in 7 read 2 instead of 3.

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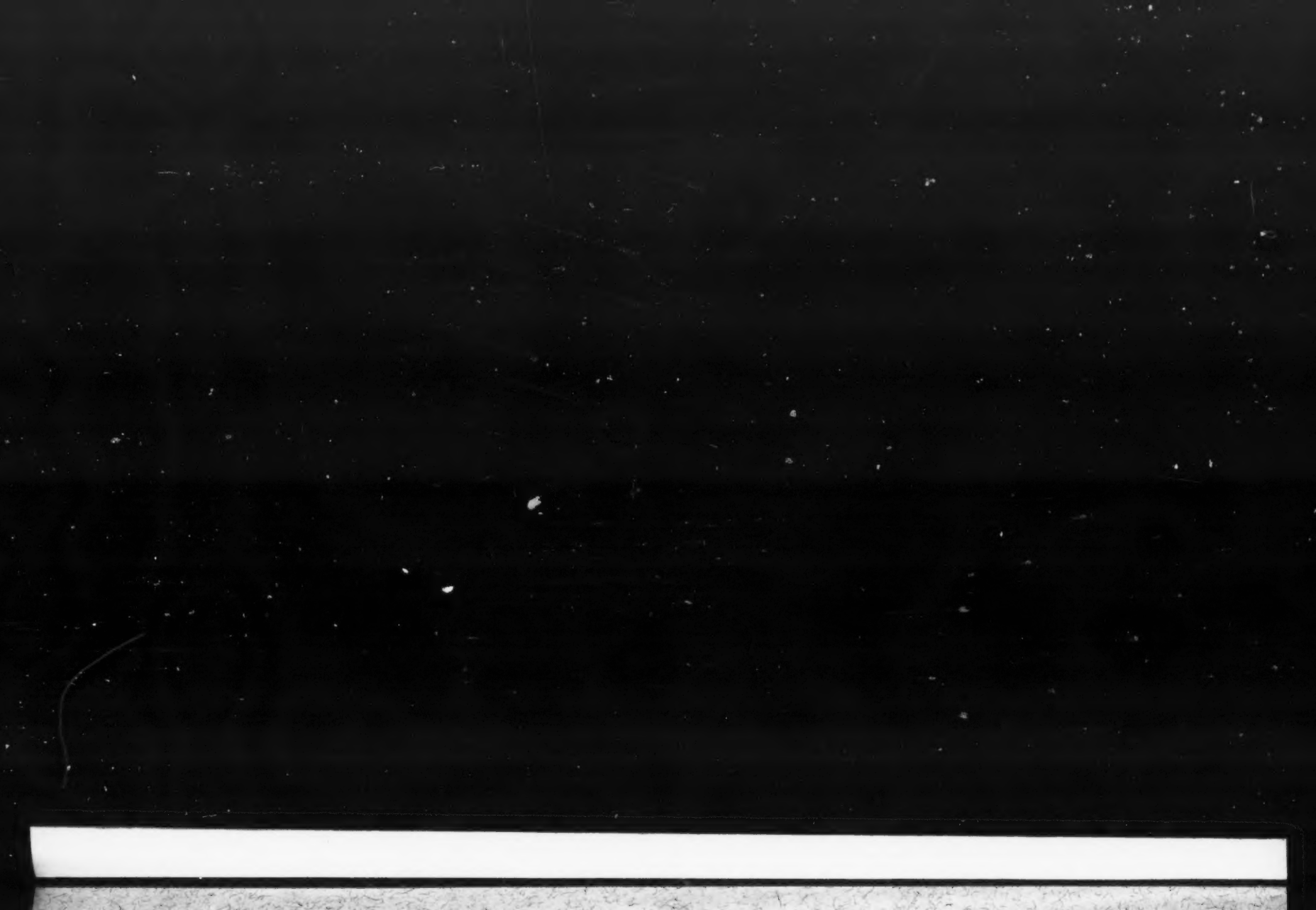
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